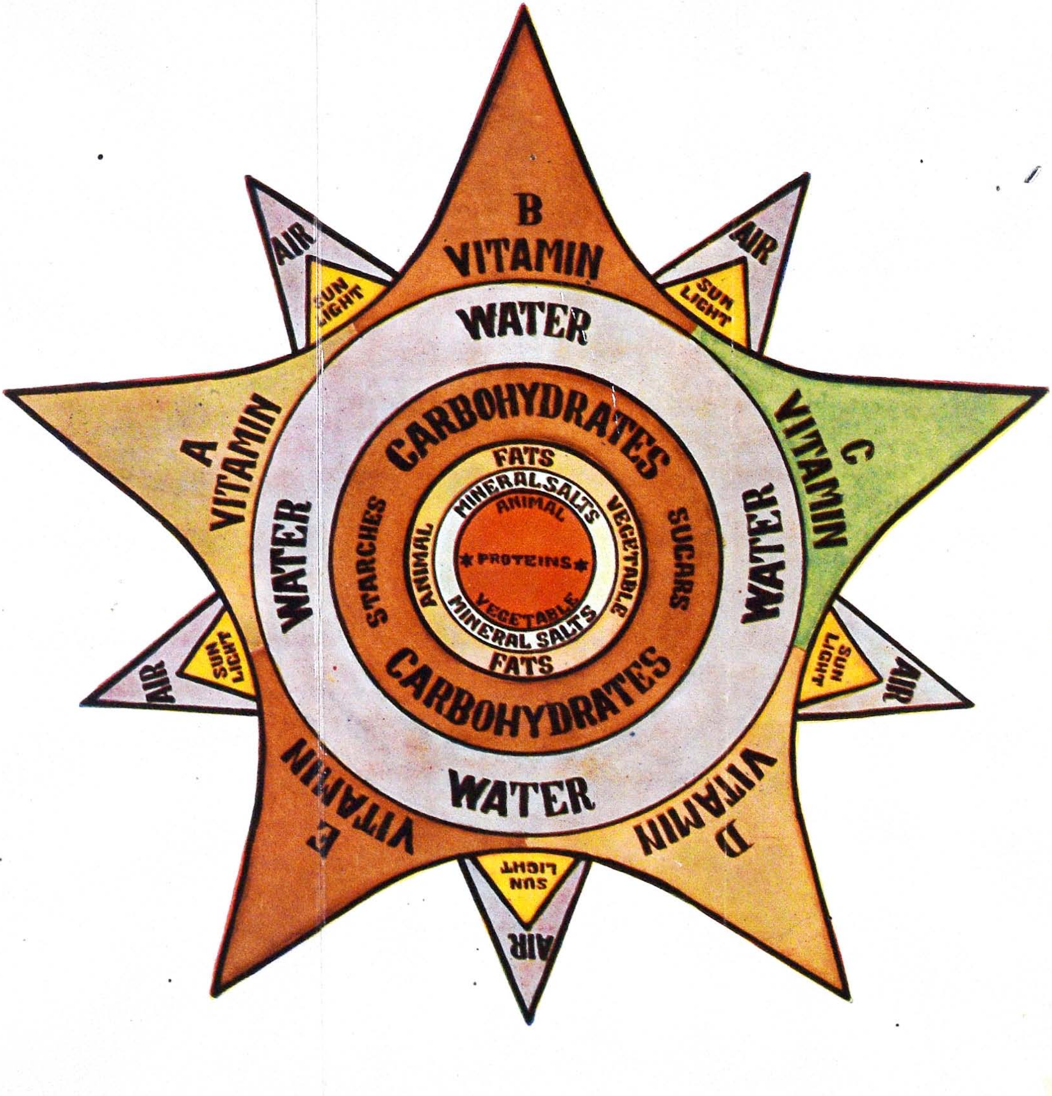
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A PRIMER FOR USE IN SCHOOLS, COLLEGES, WELFARE CENTRES, BOY SCOUT AND GIRL GUIDE ORGANIZATIONS, ETC., IN INDIA

BY

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TO

THE CHILDREN OF INDIA

The royalties on the sale of this book are devoted to certain Indian charities.

hoped that this book may serve as a collective answer. In preparing it the simple foods which Nature provides have been alone referred to; for these, when properly combined, furnish all the body needs at every period of life.

Some may say that poverty will prevent the masses in India practising the principles laid down in this primer. This is, unfortunately, only too true. But it must be realized that normal nutrition and health cannot be maintained on many of the diets now used by millions of the Indian People. Their welfare demands the provision of food which will satisfy the physiological needs of the body; education is the first step towards the attainment of that end.

R. McCarrison.

Pasteur Institute,
Coonoor,
15th March 1928.

FOREWORD

Nutrition is the most pressing of all present day problems in India; and although for many millions of the Indian People this problem is one of obtaining enough to eat yet it is well that the rising generation, amongst the more educated classes, should learn something of the simple truths of Nutrition, and how to make the best use of such food-stuffs as are obtainable. Thus may they derive benefit themselves and be in a position to instruct others.

The purpose of this little book is to teach young people what to eat and why they eat it, to make them realize that the greatest single factor in the promotion of good health is good food, and that we eat not only to live but to live well. For well-living consists in many things besides the satisfaction of appetite: it consists in the perfect growth of mind and body, in perfect health, and in the vigorous employment of both mind and body in useful work. And well-living necessitates the observance of certain rules of life, of which, from the point of view of Hygiene, there are six: to practise personal cleanliness; to live in clean surroundings; to breathe clean air; to drink clean water; to make use of the invigorating and cleansing qualities of sunlight; and, to eat, with restraint, clean food of the right kind.

The primer has been written in response to many requests for information regarding **food** received from missionaries, planters, school-teachers, child welfare workers and others throughout India. It has not been possible to reply individually to these requests, but it is

CONTENTS

Lesson		Page
	Foreword	
I.	Purposes of Food	1
II.	Food-Star : Component parts of food ...	7
III.	Air, Sunlight and Water	11
IV.	The Proteins of Food	17
V.	The Mineral Salts of Food	23
VI.	Calcium, Phosphorus, Iron, Common Salt, etc.	27
VII.	The Fats of Food	32
VIII.	The Carbohydrates of Food	37
IX.	The Vitamins of Food	40
X.	Vitamin A	44
XI.	Vitamin B	49
XII.	Vitamin C	56
XIII.	Vitamin D	61
XIV.	Milk, Curds, Cheese, Butter, Ghee, Liver, Eggs, Meat, Kidney, Brain, Fish ...	65
XV.	Cereal Grains : Wheat, Atta, White Flour, Ragi	73
XVI.	Rice, Oats, Barley, Cholam, Cambu, Maize, Linseed	79
XVII.	Dhals, Peas, Beans, Nuts, Leafy Vegetables, Fruits	84
XVIII.	Tuber and Root Vegetables ; Vegetable oils, Coffee ; Tea ; Condiments ; Choice of Food.	89
XIX.	Faults of Indian Diets and how to rectify them ; Faults of Anglo-Indian and European Diets in India	93
XX.	The Teeth	101
XXI.	The Gastro-intestinal Tract	104
	The right kind of Food	104
XXII.	The Amount of Food needed : Well balanced and badly-balanced diets ...	108
	Table of Food Values of Common Food-Stuffs	116

ILLUSTRATIONS

Food-Star ... ... *Frontispiece*

Section of Cereal Grain 74

LESSON I

Purposes of food. Until we reach the age of 20 years or so our bodies are continually growing or being built; after that their building is complete. During the period of *growth*, as well as throughout life, some part or other of the body is in constant work or movement: the heart beats, driving blood to every part; the lungs take in the air, and with it the oxygen without which we cannot live, and pass out through the mouth and nostrils harmful gases that are generated by the body's work; the stomach and intestines digest the food, transferring to the blood-stream the materials which the body needs for its growth, repair and work; the bowels, the kidneys and the skin discharge waste materials; the brain directs the body's actions; and the muscles move the limbs. All this work and movement involves constant wear and tear so that some amongst the myriad cells of which the body is composed are always in need of replacement and *repair*. **The first purpose of food** is thus to provide the materials necessary for the growth and repair of the body.

The bodily movements—and there are many different kinds of which we are not even conscious—require force or *energy* for their performance. **The second purpose of food** is to provide the materials with which the body generates this energy. In its generation *heat* is produced whereby the body is kept warm.

Food has other purposes, but they are all servants of these two: the growth and repair of the body and the

generation of energy and heat. And these two serve one great end: the maintenance of the vital force within us at the highest level of perfection. We eat, therefore, not only that we may live but that we may live in perfection of manhood and womanhood.

The growth or building of the body. In some ways the growth of the body is like the building of a house. When we wish to build a house we first select the different **building materials** that are needed: stones for the foundation; bricks for the walls; wood for the window-frames and doors; and tiles for the roof. But the stones, the bricks, the wood and the tiles are lifeless things: they cannot make themselves into the different parts of the house; so **builders** or workmen, whom we call stone-masons, bricklayers and carpenters, must be employed to prepare the building materials and to put them together. According as the building materials are good, bad or indifferent, and according as we employ good workmen for each kind of work, so the house, when finished, will be good, bad or indifferent. It is much the same with the building-up, or growth, of the bodily house: once badly built it needs continual patching.

From the food we eat the intestines select the different **building materials** needed for the building of the bodily house. These materials are passed into the blood-stream, which supplies each part with the special things required to build it. But the body-building materials—called **proteins** and **mineral salts**—are nearly as lifeless as those used to build a house: they cannot make themselves into the different parts of the

body; **builders** are needed. The great builder of the body is the vital force within us, employing many assistants. Some of these assistants are called **vitamins** because they are essential to life; they do much the same kind of work in the building and repair of the body as the stone-masons, the bricklayers and the carpenters do in the building and repair of a house. And like these workmen the vitamins have each their own particular names: they are named after the letters of the alphabet, and are called Vitamin A, Vitamin B, Vitamin C, Vitamin D and Vitamin E. The vitamins have each their own particular kind of work to do, though each helps the other in the building of the whole body: like the stone-mason who works on the foundations, the bricklayer who works on the walls and the carpenter who works on the window-frames and doors, all help in completing the whole building. Thus: vitamin A works principally on the eyes, the lungs, the stomach and intestines; B on the brain, the nerves, the flesh or muscles, and the muscles of the heart, stomach and intestines; C on the blood; and D on the teeth and bones. If the food be of the right kind all these vitamins are present in it together with the building materials with which they do their building. But if the food be of the wrong kind it may contain neither enough building materials nor enough vitamins for the proper building, or growth, of the body. So the body as a whole, or some part of it, may be badly built and fail to do well the work for which it is intended; in the same way that the roof of a house may leak and let in the rain when the materials used in building it are bad, or when the builders of it are bad

workmen. Thus the bones, whose duty it is to support the body, may be frail or bent; the teeth, whose duty it is to chew the food, may be poor and decay early in life; the muscles may be flabby and the limbs not supple for movement, play and labour; the lungs whose duty it is to provide the body with **oxygen,** may be weak and work imperfectly, or the stomach and the intestines, whose duty it is to digest and absorb the food and to pass the waste materials of digestion out of the body, may be too weak to do so properly. It is in this way that a great many illnesses are caused. Presently we shall learn what these illnesses are.

In other ways the human body is like a steam-engine, though vastly more complex and more perfect. The engine may be perfectly made, but without **steam** it cannot move nor pull its load of waggons. The steam it needs is made by heating **water** in the boiler of the engine by means of a fire. The fire is fed with **fuel,** such as coal or wood; and the steam, as it is made, passes into the cylinders of the engine. There it presses upon the pistons causing them to set the wheels in motion and the engine to move and pull its load. The heat from the fuel makes the steam; the steam provides the *energy* to make the engine move; and the more work the engine has to do, the quicker it goes and the heavier the load it has to pull, the more steam and, therefore, the more fuel it needs. It is much the same with the human body. It too, may be perfectly made, but without its own kind of steam, or energy, it cannot do its work. This energy is provided much in the same way as the steam is provided for the steam-engine. There is in each one of us a kind

of fire which we may call *the fire of life*: we cannot see it, but we feel it is there because it keeps our bodies warm. Like the fire of the steam-engine this must be fed with fuel. This fuel is provided by other constituents of our food called **fats** and **carbohydrates,** which are therefore spoken of as **fuel foods.** They contain great stores of energy. From them and from the proteins left over from the building and repair of the body, energy is liberated by the vital fire within us, and so the bodily engine is enabled to do its work. The more work it has to do, the more fuel it needs. The **water** in our bodies helps greatly in the production of the energy needed for this work.

Another source of the body's vigour is **sunlight,** which also provides the energy that is stored in the carbohydrate constituents of our food.

Now the fire in the steam-engine will not burn properly unless it has plenty of air. We all know how we blow upon a fire, or use bellows, to make it blaze. It is the **oxygen** in the air which causes the fire to burn and blaze. It is just the same with the fire of life. It too, needs plenty of **oxygen** and our lungs are the bellows which provide it. The fire in the steam-engine gives out heat; so does the fire in our bodies, keeping us warm. But in order that we may not get too hot, nor our blood too thick, nor our skin and flesh too dry, we need to drink *plenty* of **water.**

The things needed for the proper nourishment, growth, repair, work and health of the body are thus of four kinds: **air, sunlight, water** and **food.** To these must be added **exercise** and **sleep,** both of which are outside the scope of this primer.

The essential ingredients or parts of the food are of five kinds: **proteins, mineral salts, fats, carbohydrates** and **vitamins.** Each one of these ingredients is as important as another and each depends for its proper action on every other; our food must contain them all in just the right amount and kind. Every food-stuff that Nature provides for our use contains *some* of these essential ingredients, but no single food contains them all in just the right amount. So we must learn how to mix the different things we eat in such a way that our daily food will contain all of these five essential substances in the right kind and proportion.

LESSON II

Food-star. On the front page of this book there is a coloured star which we shall call our **food-star** because it is intended to guide us. It shows all the substances needed by the body for its proper nourishment, growth, repair, health and work.

In the centre of the Star there is *a small red area* marked **proteins;** above the word 'proteins' there is the word 'animal' and below it the word 'vegetable.' This is to remind you that the proteins occur both in foods obtained from animals and in foods obtained from vegetables, and that it is best to use both kinds. Proteins are the **building materials** needed to make the flesh, and organs such as the brain, liver, heart and kidneys; and since flesh is red, the central area of the Star is coloured red. Animal proteins occur in milk, meat, eggs and fish; vegetable proteins occur in cereal grains such as rice, wheat, oats, barley, maize, ragi, cholam and cambu, and in nuts, vegetables and fruit.

Around the red centre of the Star there is *a narrow white circle* marked **mineral salts:** these are the second kind of **building materials;** they are needed to build the bones and teeth, to keep the blood pure, and for other purposes about which we shall learn in another Lesson (V). The circle showing the mineral salts is white because these salts are usually white. They are things like lime (*chunam*) and common salt (*nimuk; oopoo*). They occur in most food-stuffs, but vegetable

foods such as fruits and green leafy vegetables are particularly rich in them.

Around the white circle there is *a narrow yellow one* marked **fats** above and below, and at the sides 'animal' and 'vegetable.' This circle is coloured yellow because the body-fat is yellow, and because most of the foods, such as butter, which provide fats, are yellow. The words 'animal' and 'vegetable' are to remind you that **fats**—which are one kind of **fuel food**—occur both in foods obtained from animals and in foods obtained from vegetables and that it is well to use both kinds. Examples of animal fats are butter, ghee and fish oils; examples of vegetable fats are margarine, cocogem, gingelly oil, olive oil, ground-nut oil and linseed oil.

Around the narrow yellow circle there is *a broad brown one* marked **carbohydrates**; on one side is the word **starches** and on the other the word **sugars**, to show that these are the two kinds of carbohydrates. The carbohydrates are **fuel foods** like fats; but the brown circle is much broader than the yellow one because the body needs more carbohydrates than fats; for the carbohydrates, like wood-shavings, burn quickly, while the fats, like logs, burn slowly; so the carbohydrates help the fats to burn properly. The carbohydrate circle is coloured brown because the earth is brown, and because we get carbohydrates from all foods which grow in the brown earth: *the starches* from such grains as rice, wheat, oats, barley, maize, ragi, cholam and cambu, and from tubers and roots like potatoes, yams and tapioca; and *the sugars* from fruits, sugarcane, beetroot and other plants.

Around the broad, brown circle there is *a large, pale-blue one* marked **water.** It is large because the body needs so much water, and it is coloured pale-blue because water, by reflecting the blue of the sky, so often appears to be of this colour.

Coming out of the **food-star,** but really running through it if this could be shown in the picture, there are five large rays: two yellow, two brown and one green. These represent the five **vitamins**—A, B, C, D and E; and they are so coloured to remind you of the kind of food in which the vitamins are found. A and D are coloured yellow because they occur so often in yellow foods, such as animal fats, milk, butter, ghee, egg-yolk, fish-oils, carrots, tomatoes, sweet potatoes, bananas and yellow root-vegetables. B and E are coloured brown because they are plentiful in the same kinds of foods as the carbohydrates, such as rice, wheat, maize, barley, oats, ragi, cholam and cambu. C is coloured green because it is plentiful in green vegetables, such as cabbage, lettuce, turnip tops, bamboo shoots, pine shoots, water cress and lucerne grass. We shall learn in other Lessons that the different vitamins occur also in other foods, but for the present the colours by which they are represented in the **star** will serve to fix their chief sources in the memory.

You will notice that the five vitamin rays of our **food-star** are all connected: this is to remind you that they all work together in building and nourishing our bodies and in keeping us in good health, just as they work with all other substances comprising the body of the Star.

Now this Star, with its five vitamin rays, is made up of the same substances which compose our bodies—water, mineral salts, proteins, carbohydrates (starches and sugar), fats and vitamins—so that we can only grow and remain in good health when the food contains them all in proper proportion. If one be missing or too small in amount the Star is incomplete, and so is the food. The sizes of the different circles show roughly the proportion of each constituent of the food to every other.

If you remember how the **food-star** is made and arrange your food so that it contains all the substances in the Star, then your bodies will always get the right materials for growth, vigour and health, whatever your age may be. In other Lessons we shall learn how to do this: but first we must know something more about air, sunlight and water.

LESSON III

Between the vitamin-rays of our **food-star** there are five smaller ones, the sides and tips of which are coloured blue and the bases of which are coloured yellow. The sides and tips are blue to represent the **air** where the **oxygen** comes from; and the bases are coloured yellow to represent the yellow rays of **sunlight** coming through the blue air to our bodies, and to the plants which prepare, under the influence of sunlight, so much of our food for us.

Air. When we breathe we take air into our lungs with every breath. The air contains a gas called **oxygen**. We cannot, of course, see it but none the less it is one of the chief constituents of our food. It is this gas which makes *the fire of life* burn briskly. The lungs are so made that they take out of the air as much oxygen as they can; they pass the oxygen into the blood-stream as it flows through them before it goes to every part of the body. In the blood-stream and tissues the oxygen meets the **fuel foods**, which the stomach and intestines have passed into the blood, and burns them up to yield heat for our bodies and energy for their work. Now as a fire burns it gives off gases which we see as smoke; so does the fire of life in the human body. These gases are poisonous and if they were not removed from the body, as soon as they are formed, we would become ill. So the blood collects them on its way through the body and brings them to the lungs

where they are discharged with the air we breathe out, and are carried away, by movement of the outside air, to be used by plants. If we sleep in rooms of which the windows and doors are tightly shut and through which no current of fresh air is passing, or if we sleep with our heads covered up with a blanket or sheet, as so many people in India do, then the air we breathe will contain less and less oxygen with every breath we take in, and more and more poisonous gases with every breath we let out. So our lungs, and through them our bodies, will not get enough oxygen, and we shall be breathing impure air filled with harmful gases. It is necessary, therefore, to live and to sleep in the open air, or in rooms with open windows through which fresh air is always passing. If we do not do this our lungs become weak, and so we are apt to get 'colds' and dangerous diseases of the lungs while our bodies are sluggish because the fire of life is not burning as it should. Want of fresh air is one of the chief causes of ill-health and of lung disease. Always breathe deeply, through the nose and not through the mouth.

Sunlight. All animal life depends on plant life and all plant life on sunlight. Animals and man must either live on plants themselves or eat animals that do. Plants manufacture proteins, fats, carbohydrates and vitamins from substances which their green leaves extract from the air or their roots from the soil. By their roots they also extract from the soil the mineral salts which are so necessary a part of food. The gases and other refuse matter which pass from our bodies and from the bodies of animals are utilized by plants and re-

converted into food suitable for our use and for the use of animals whose milk or flesh we use as food. Plants are enabled to do this because of the action of sunlight on their leaves. Sunlight is the source of the energy whereby they do their work; and plants have the power of storing some of this energy in the carbohydrates they make, so that it is available for man and for plant-eating animals. It is thus the **sun** that provides, through the agency of plants, the proteins, the fats, the carbohydrates, the mineral salts and vitamins which our bodies require for their growth, repair and work. The sun is the great life-giver; it is also the great cleanser, destroying many kinds of disease-producing microbes when they are exposed to its rays.

The sun's rays can also produce certain vitamins in our own bodies. One that may be so formed is vitamin D, which is necessary for the building of our bones. Children in India who run about in the sun never suffer from weak or bent bones like children often do who live in less sunny countries. But if children in India be kept indoors all day in dark rooms, or only come out in the evening when the sun has set, then their bones may become weak and bent, causing a disease called rickets. And if girls remain always in purdah they may suffer in the same way, as many purdah women in Kashmir do. One way to prevent this is to eat foods which contain vitamin D. But as these are not always easy to get the simplest thing to do is to bask in the sun for some period of each day.

There are two kinds of rays in sunlight: those we can see and those we cannot see. The latter not only

cause vitamin D to be produced in our bodies, thus preventing the bones from becoming weak, but they stimulate the lungs, the nerves and the blood, thus increasing bodily vigour. Too great exposure to strong sunlight is harmful and so our bodies have to be protected against it. This Nature does in Indian children by making their bodies brown so that they can go out into the bright sunshine quite naked without much harm. Fair skinned children, living in India, where the sun is very strong, cannot do this. They must have most of their bodies clothed, and their heads covered with thick *topees*, to protect them.

This section of to-day's Lesson has been added so that you may learn two things: (1) how great a friend we have in the sun, and (2) how to use the sunlight for our health and well-being.

Water. Strange as it may seem to you the greater part of our bodies is made up of water. Nine-tenths of the blood is water, and nearly three-quarters of our flesh. It is the water in the blood and tissues which carries the things that nourish us to every part of the body, and which removes from the body certain waste materials that are produced in the course of its work. The body is porous like an earthen jar (we see that this is so when we get hot and perspire). Being porous it is always losing water, which appears on the surface of the skin, as sweat, where it evaporates keeping the body cool. Children in India know how water can be kept cool in an earthen jar by the evaporation of the moisture which soaks through its porous wall. We also lose water from the lungs, as any child can see who

breathes on a piece of cold glass. Water also passes out of the body through the kidneys, carrying with it waste materials produced in the course of the body's work; it also passes out of the body by way of the bowels, carrying with it waste materials from our food. It flushes from the body things that are harmful to it and keeps it clean inside. As the body is so largely made of water and is so constantly losing it, it is constantly needing to be given more. The need for water is shown by the sensation which we call 'thirst.' Many people do not drink nearly enough water, and so they have little energy, their blood becomes thick and impure, their food is not properly digested, their bowels are not kept in proper health while their bodies become too hot and are not kept clean inside. Every day first thing in the morning and between each meal we ought to drink a glass or two of cold water whether we feel thirsty or not. Taken in this way in the early morning it helps greatly in making the bowels act properly. Water is even more necessary to keep our bodies clean inside than it is to keep them clean outside. People who are very ill must be given plenty of water, so also must infants between their feeds of milk.

The water we drink must be pure, and not soiled by dirty matter passing into it; otherwise we may get from it dangerous diseases, such as dysentery, typhoid fever and cholera, which are due to microbes present in dirty water. It is very likely to be impure and to cause illnesses when it flows in open channels through villages and fields, or when it is taken from wells that are not properly protected from pollution. When in

doubt as to the purity of the water we have to drink, we should boil it before use. When water is drawn for use in our homes it must always be kept well protected in clean vessels.

Not counting the water which is contained in every food-stuff we eat, we should drink two or three pints of pure water every day. It will give you an idea of how much water there is in some food-stuffs when you are told that three-quarters, by weight, of a potato is water; about one-eighth part of all cereal grains is water, more than three-quarters of an egg is water, and by far the greater part of a tomato is water. Indeed, if we were to add up the amount of water in everything comprising our daily food we should find that more than half of it is water; from which you will understand how very important a constituent of our food water is, and how very necessary it is for our health and well-being.

LESSON IV

The Proteins. These are jelly-like substances formed by living matter and necessary for its life: examples of them are white of egg and curds of milk. They all contain a substance called **nitrogen** which is one of the principal materials needed for making the millions of new cells that are formed during the growth of the body; it is needed also for the constant renewal of worn out cells. Proteins are the chief **body-building materials**, besides being stimulants of bodily activity.

They occur in all living matter and, therefore, in all animals and in all plants which we use as food. Those present in the animal part of our food are called 'animal proteins,' and those in the vegetable part, 'vegetable proteins.' The animal proteins differ from the vegetable ones, and both differ from those in the human body. They are all made up of some eighteen fragments which are called amino-acids, and they differ from one another because of the different combinations of fragments comprising them; just as words differ from one another because of the different combinations of letters forming them.

Since both the animal and the vegetable proteins are different from those in the human body, the proteins of food must be *re-formed* into those that are needed for the different parts of our bodies. When the food-proteins are taken into the stomach and intestines they are split up into their different fragments. These frag-

ments are then sorted out, some of them being *re-formed* into the new proteins needed to build and repair our tissues. The fragments not needed for this purpose, or that cannot be used in this way, are either passed out of the body or are used, with the fats and carbohydrates, for the generation of energy. Some food-stuffs contain proteins that can be easily re-formed by the human body into the new kinds needed for the building and repair of its different parts, and some contain proteins that cannot be so easily re-formed. We speak of the proteins that can be easily re-formed as being 'suitable' for the human body, and of those that cannot as being 'less suitable' or 'unsuitable'. The animal proteins are of the suitable kinds because they resemble most nearly those in the human body; the vegetable proteins are of the less suitable or unsuitable kinds because they differ most from those in the human body.

Now it is very important, especially during the period of growth, that the food should contain both enough proteins and enough *suitable* proteins. For when there are enough suitable ones they enable the less suitable or the unsuitable ones to be made use of by the body. It is not that the unsuitable proteins are of no use; they can be very useful, but in order to make them of use they need to be associated with the suitable proteins.

It is as though all the proteins provided fragments resembling the consonants in the alphabet (b,c,d,f,g,h etc.) while only the suitable ones provided fragments resembling the vowels (a,e,i,o and u) as well as the consonants. With enough vowel-like fragments all

words—representing proteins—can be made from the consonant-like fragments. So the unsuitable or less suitable proteins, which do not provide any or enough vowels but do provide the consonants, can be made use of when enough suitable proteins are present to provide the vowels.

We must, therefore, know what foods contain 'suitable' proteins and what foods contain proteins that are 'less suitable' or 'unsuitable':

(1) **Foods containing suitable proteins** are milk, curds, buttermilk, cheese, eggs, kidney, liver, meat, sweetbreads, fish, green leafy vegetables such as spinach, lettuce, watercress and sorrel, and the young shoots of edible plants. Whole wheat flour (*atta*) contains some suitable proteins, though more that are less suitable.

(2) **Foods containing less suitable proteins** are whole wheat flour (*atta*), oatmeal, barley, ragi, cholam, cambu, unpolished rice, peas, beans, dhal, gram, nuts of all kinds, potatoes, carrots, turnips, parsnips, beetroot, artichoke, sago, fruits of all kinds and all vegetables except green leafy ones.

(3) **Foods containing unsuitable proteins** are polished rice, white flour, tapioca and maize.

(4) **Foods containing no proteins** are sugars, animal fats and vegetable oils, such as gingelly oil, arachis oil, mustard oil, linseed oil and cocoanut oil.

It is not necessary to depend solely on the foods containing suitable proteins for all the proteins needed; it is best to combine them with the foods mentioned in classes (2) and (3) so that the body can make use of the less suitable and unsuitable proteins contained in cereal

grains and other vegetable foods. This is also the cheapest thing to do because those containing suitable proteins are the most expensive foods.

The principal part of Indian children's food is made up of the grain or grains which grow best in the part of India in which they live. Some children eat wheat, others rice, others ragi, others cholam, others cambu and others maize. These grains are called the **staple articles** of the diet. With them they eat a little dhal and perhaps some vegetables, fruit and ghee or vegetable oils. Very often this is all they do eat; so that their food often provides only proteins that are of the less suitable or of the unsuitable kinds. These children *cannot* grow as well nor be as strong and healthy as those who also take foods containing suitable proteins, such as milk and milk-products, or eggs, or meat *and* green leafy vegetables. Deficiency of *suitable* proteins is one of the commonest faults of Indian dietaries.

Some children in India are not allowed by their religion to eat eggs or the flesh of animals; but all are allowed to take milk and milk-products. So that no matter what may be their religion and no matter what their staple articles of diet, the food will always contain the right kinds of proteins, if it includes enough milk and the products of milk, such as curds, buttermilk and cheese, *and* if it contains a sufficient amount of green leafy vegetables. If it contains enough of these it does not matter whether the staple article of the diet is wheat, or rice, or ragi, or cholam, or cambu, or maize. Unfortunately milk is scarce in India and children cannot always get enough of it; but when it is realized

how very important it is that children should get enough of it, perhaps more milk will be produced. *Where there is a will there is a way.*

In other Lessons we shall learn that a diet consisting of any staple grain with milk, milk-products and green leafy vegetables contains not only the right kind and amount of **proteins** but everything else the body needs for health, strength and well-being.

It is very important that our food should contain the right amount of proteins: neither too much nor too little. If we eat too much protein-containing foods, such as meat, eggs and dhals, a lot is left over in the intestines where it is wasted and goes bad, like meat does when it is kept in a warm place. When this happens we may get ill because poisons are absorbed from the intestines into the blood: these poisons cause headache, fatigue, and sometimes pain and swelling of the joints.

Since proteins supply materials necessary for the building and repair of the body it follows that if the food does not contain enough of them or if it contains only proteins of the less suitable or of the unsuitable kinds, our bodies will be badly built, badly repaired and will not wear well. The **ill effects** of this will be seen in stunted growth, poor physique, poorly developed muscles, lack of vigour, low powers of endurance, incapacity for hard-work both physical and mental, rapid advance of old age, and short life. The power of resisting diseases, such as tuberculosis, cholera, dysentery, malaria and leprosy, will also be reduced.

Vitamins A and B are necessary for building the

proteins of the food into living tissues. The more proteins there are in the food the more of these vitamins are needed. The amount of food-stuffs in the diet—such as meat, liver, eggs, dhals and nuts—containing much protein should not be more than one-fourth by weight of the amount of vegetables and fruit.

LESSON V

The Mineral Salts. These are the second class of body **building materials.** They are substances like lime, phosphates, sulphur, and the 'common salt' which we take with our meals. They are the ashes left after the burning of food in the air, like the ashes left after the burning of wood or coal.

The mineral or inorganic salts form about one twenty-fifth part of the whole body. The bones and teeth contain by far the greatest part of them; but some are also present in the flesh (muscles) and other soft tissues, and some are dissolved in the blood and body-fluids. Those in the tissues, blood and fluids are as necessary for our well-being as those that build the bones and teeth: they prevent the blood, tissues and body-fluids from becoming acid or sour. If the blood were to become even a little acid we should get ill, or if more acid we should die; the mineral salts, when properly mixed in the food, help to prevent this happening. They also help the muscles, both those that move our bodies and those that move parts of our bodies which we cannot see (like the heart, the lungs and bowels), to do their work efficiently. Every time the heart beats, driving blood to the finger tips and back again to the lungs, these mineral salts help to make its beating possible; while but for some of them enough water would not remain in the tissues, the kidneys would not act properly nor the body be

cleansed of its waste products, nor would the stomach and other organs of digestion produce the digestive secretions. Were we starved of all mineral salts life would be as impossible as if we were starved of all water or of all food; and unless our food contains them all and in the right proportion good health is impossible.

There are twenty different mineral *elements* in the body; from these the many kinds of mineral *salts* are made. The chief of these elements are: calcium, potassium, sodium, iron, magnesium, manganese, zinc, copper, lithium, barium, phosphorus, sulphur, chlorine, iodine, silicon and fluorine. The first ten are *alkali*-forming elements, the last six are *acid*-forming elements. Of the *alkali*-forming elements calcium, potassium, sodium, iron and magnesium are the most important and exist in the body in the greatest quantity; the remaining five being present in very small amounts. Of the acid forming elements phosphorus, sulphur and chlorine are the most important. When there is the right proportion between these two classes of mineral elements then the blood, the body-fluids and tissues are of the right *reaction*: that is to say, they are neither too alkaline nor too acid.

When the food is of the right kind all twenty mineral elements are present in it and in the right proportion; but no single food-stuff, with the exception of milk, contains them all in just the right proportion; even milk, as we shall learn in Lesson XIV, is poor in iron.

Some food-stuffs such as green leafy vegetables, tuber and root vegetables and fruit, are rich in *alkali*-producing elements and poor in acid-producing ones.

While others, such as meat, dhals, pulses, nuts and cereal grains, are rich in acid-producing elements and poor in *alkali*-producing ones. The green leaves of plants are always rich in just those mineral salts in which the seeds, such as grains and nuts, are poor. So it is necessary, when our food consists largely of such cereal grains as wheat, rice, cholam, cambu, ragi, maize or barley, or when we eat flesh meat that we should also eat plentifully of the green leaves of plants.

The mineral salts of the staple food grains—wheat, rice, ragi, etc.—are mostly contained in the outer covering of the grains. When these outer coverings are completely removed, as when *paddy* is made into polished rice or when wheat is made into white flour, then much of the mineral salts, such as those of calcium, phosphorus, iron magnesium, manganese, potassium and sodium, are lost. We shall learn in Lesson XI that most of the vitamins in the grains are also lost in this way, as well as a great deal of their proteins. A good rule to remember is that when the grains we eat contain vitamins they will also contain some of the building materials (mineral salts or proteins) needed by our bodies, and that when vitamins are lacking in foods made from these grains mineral salts or proteins will be lacking too unless our food contains other materials which provide them. Thus polished rice and the white flour made from whole wheat contain neither enough building materials for the bones, teeth and tissues, nor enough builders (vitamins) to build them into the body. For want of both, the bones and teeth may not be strongly built, nor organs like the heart, the lungs and kidneys as sound as they ought to be.

When we suffer from any kind of fever the blood tends to become acid. It is, therefore, very important that during attacks of fever we should drink plenty of water with fruit and vegetable juices and avoid acid-producing foods such as meat, soups and cereal grains.

If our food consists of milk, milk-products, whole cereal grains, *plenty* of green leafy vegetables and fruits, it will contain all the mineral salts we need and in the right proportion. But if it consists of cereal grains with meat, eggs, nuts and *boiled* vegetables, with only a little milk, a little fresh fruit and a little green leafy vegetables then it will not contain all the mineral salts and it will give rise to a state in which the blood, fluids and tissues of our bodies are too acid for the most vigorous health. In the next Lesson we shall learn how different foods vary in their content of these mineral substances.

LESSON VI

Calcium is one of the most important of all the mineral elements of the food ; it is the principal ingredient of lime (*chunam*). It is needed for the building of the bones and teeth, to make the heart work properly, to make the blood clot so that too much blood is not lost if our bodies are cut or wounded, and to help our bodies to use properly certain other constituents of food, such as fats and iron. Calcium is more often lacking in food than almost any other ingredient, and a shortage of it is a very common cause of ill-health both in children and older people. Too little calcium in the food may be one of the causes of general bodily weakness, of softening of the bones, of decay of teeth and of rickets.

Foods that do not contain enough calcium are (1) cereal grains, like wheat, rice, cholam, cambu, ragi and maize ; (2) tuber and root vegetables, like potatoes, yams, radishes, turnips, beetroots and carrots ; (3) sugar, jams, tapioca and sago ; and, (4) flesh meats. So if our food is made up mostly of such things as these the body will not get enough calcium, while it will get too much of certain other mineral salts.

Foods containing plenty of calcium are milk, buttermilk, cheese, whey, yolk of egg, nuts, dhals, fruits of all kinds and green leafy vegetables. If our diet includes enough of these things it will contain all the calcium we need. Milk is the most important of all sources of calcium. A pint a day contains all the calcium

a child needs. Women and children need more calcium than other people. For every pound of his body-weight a growing boy requires about three times as much calcium as a man.

Phosphorus is a very important constituent of the bones and teeth, in which it exists as the mineral salt called *calcium phosphate.* Every cell in the body contains phosphorus; it is the multiplication of these cells which enables the body to grow; phosphorus is essential to the multiplication of cells and the growth of the body. It is also a very important part of the blood. **Foods rich in phosphorus** are milk, buttermilk, eggs, soya bean, dhals, nuts, wheat, oats, barley, cholam, ragi, watercress, spinach, radish, cucumber, carrot, cauliflour, brussels-sprouts, meat and fish.

White rice, white flour, tuber and root vegetables are poor in phosphorus.

While too little phosphorus in the food may cause the bones and teeth to be badly made, too much phosphorus and too little calcium is also *one of the causes* of imperfect bones and teeth. We should, therefore, always combine the foods that are rich in phosphorus with others containing plenty of calcium.

Iron is another very important mineral constituent of food. It gives to the blood its red colour and enables it to carry oxygen from the lungs to every part of the body. More iron is needed by women than by men, and by growing children than by grown up people. If the food contains too little iron the blood becomes poor, and there is not enough oxygen to make the fire of life burn briskly. So we may suffer from weakness, a

feeling of weariness and anaemia. **Foods containing little iron** are animal and vegetable fats, sugar, white rice and white flour. **Foods containing iron** are liver, red meat, eggs, dhals, whole cereal grains, spinach, leeks, lettuce, onions, radish, strawberries, artichoke, water-melons, asparagus, celery, cucumber, dandelion, turnip leaves and tomatoes. Vitamins, A, B, C and E as well as calcium and a substance produced by the liver are necessary for the proper utilization of iron by the body. If these be not present in sufficient amount the blood may become poor or anaemic, although there may be plenty of iron in the food.

Common salt (*Nimuk*, *Oopoo* or sodium chloride) is needed by the body for many purposes. Three of them are enough to remember; it helps to keep the blood of the right composition, the right amount of water in the tissues, and the different organs acting properly. People who live only, or mainly, on vegetable foods, such as potatoes, vegetables and dhal must add 'salt' (*nimuk*) to their food as there is too much potassium and not enough sodium in these foods. Those like the Eskimos, who live chiefly on meat, need to add no 'salt' to their food as the meat contains enough sodium already. Those who take a 'mixed diet,' composed of both animal and vegetable foods, require a little salt each day, but not too much. Many people eat far too much 'salt' because they like the taste. But too much is nearly as bad as too little; it is only when our food contains a lot of vegetables that we need to take more than a small pinch of salt at each meal. Rice-eaters require very little 'salt' with their food.

Too much salt in the food may injure the kidneys and the vessels which convey the blood from the heart to the different parts of the body.

Chlorine is needed by the body to keep the blood of the right composition and to make the hydrochloric acid which helps the stomach to digest the food. **Foods containing plenty of chlorine** are bananas, celery, dates, lettuce, spinach, tomatoes, pine-apple, peanuts and green leafy vegetables. Man gets plenty of chlorine from these sources as well as from the common salt which he takes with his food.

Iodine is another important mineral constituent of the food; it is needed by an organ in the neck called the thyroid gland. It is always plentiful in vegetable foods grown in places where there is plenty of iodine in the soil. But in some places, as in the Himalayas, there may be very little iodine in the soil and so the vegetable foods grown upon it contain very little. Too little iodine in the food is *one of the causes* of a swelling of the neck, called Goitre. Iodine occurs in the sea, so sea-fish and the oil from their livers (cod-liver oil, etc.) contain a lot of iodine and are very health-giving foods. If children be given cod-liver oil or fish oil they should not be given more than one small teaspoonful of it in the day. As a rule green leafy vegetables and fruit contain enough iodine for our needs and this is by far the best way to get it. Iodine helps the body to make the best use of the fats and calcium in the food. Only very small amounts of it are needed. Large amounts are very harmful.

All the mineral salts dissolve to some extent in water;

so when vegetables are boiled before they are eaten and when the water in which they are boiled is thrown away a great part of the mineral salts is thrown away with it. This is a great mistake. The water in which the vegetables are boiled should always be kept and made up with other things into soups. It is better still that some part of the vegetables we eat each day should be eaten raw, in the form of lettuce, and tomatoes, and that each day we should eat some raw fruit.

The whole of this and the previous lesson can be summed up in a few words: All the mineral salts the body needs are contained in the right proportion in a diet which is composed of milk, milk-products, green leafy vegetables and fruit, together with any of the staple food-grains.

Illnesses which may result from the food containing too little mineral salts are rickets, weak and soft bones, thin bones, bad teeth, wasting, anaemia, lassitude, poor appetite, bad digestion, constipation, goitre and acidity of the blood.

Vitamins A, C and D are all necessary for the proper building of the mineral salts into the living tissues of the body.

LESSON VII

The fats. These are substances like butter, ghee, mutton fat (*charbi*) and vegetable oils. They occur in all our food-stuffs with the exception of sugar, jaggery or goor, honey and a few fruits.

Fats are present in the following foods obtained from animals: the fatty part of flesh meat, the marrow of bones, milk, butter, ghee, cream, cheese, liver, fish, fish oils and egg-yolk. *Charbi*, butter, ghee and liver oil are spoken of as 'animal fats.'

In vegetable foods fats occur chiefly in nuts and seeds, from which they are expressed to make the 'vegetable fats or oils'—olive oil, almond oil, cocoanut oil, gingelly oil, ground-nut oil, mustard oil, cotton-seed oil and linseed oil.

Some of our staple food grains, such as oats, cambu and cholam, contain considerable amounts of fats; others, such as polished rice and wheat contain comparatively little. Sago and tapioca are very poor in fats. Peas and beans are poor in fats; soya bean is an exception to this rule, being rich in fats. Dhals and gram contain a fair amount of fats. Fruits are poor in them. Vegetables contain little fat, but some have more than others; those containing most are asparagus, dhanrose, turnip tops, nolkole, parsnips, brinjol, artichoke, cauliflour, lettuce, spinach and brussels sprouts.

Fats are the first great class of **fuel foods** but we need much less of them than we do of the other fuel foods

(carbohydrates and spare proteins). They produce weight for weight, more than twice as much energy as either proteins or carbohydrates.

Fats are stored in certain parts of the body as a reserve of fuel for times of want and sickness. They collect under the skin, where they act like a blanket preventing loss of heat from the body, and around delicate organs like the kidneys protecting them from harm. They make the tissues firm, and fill out the contours of the body.

The animal and the vegetable fats are both equally good as **fuel** but they are not equally good for nourishing the body ; the animal fats being much the better of the two. This is because the animal fats contain an abundance of vitamin A, which is necessary for growth and health and for maintaining the resistance of the body against infectious diseases. The vegetable fats either do not contain this vitamin at all or contain it only in very small amount. It is, therefore, very necessary when we use vegetable oils as food to include in our diet other food-stuffs containing the vitamin in which these oils are poor. In India, milk, butter and ghee, which contain vitamin A, are very scarce and very often ghee is much adulterated. Those who cannot get enough milk, butter or ghee, and whose religion allows them to eat animal foods, should include liver, egg, fish or fish oils in their food ; those whose religion does not allow them to eat these things must, if they cannot get milk, butter or ghee, eat plenty of green leaves such as spinach, watercress, etc., and yellow vegetables, such as tomatoes and carrots, or sprouted grains to help to

supply the vitamins that are lacking in the vegetable oils. But it is difficult to get from these vegetable sources all the vitamin A the body needs, so that milk and milk-products are necessities which few Indian children can do without if they are to remain in vigorous health.

Some of the fresh vegetable oils though they contain little vitamin A are not wholly devoid of it (Lesson X); but now-a-days they are manufactured into 'vegetable ghee and butter' by passing through them a certain gas which hardens them; cocogem, margarine and other kinds of vegetable ghees are examples. This hardening process slightly improves their value as fuel foods, but it completely destroys any vitamins the fresh vegetable oils may have contained and thus lessens their value as nourishing foods. These vegetable ghees have, however, the great advantage of being clean; but we must remember that when we use them it is even more necessary to use with them other foods containing the vitamins they lack than when we use the fresh vegetable oils themselves. There are not enough good cows, buffaloes and goats in India to provide milk, butter and ghee for everybody; this makes it all the more necessary to use only the best and freshest vegetable oils and to grow plenty of green leafy vegetables and tomatoes so as to supply, as far as these vegetables can, the necessary vitamin A.

Fish oils which are rich in vitamins A and D, should be produced in large quantities by the various Fishery Departments and sold to the people at a cheap rate. With a little fish oil to add to vegetable oils people

would be nearly as well off as if they used butter or ghee. Soon it may be possible to make vitamin A, as it is now possible to make vitamin D; when this happens these vitamins can be added to 'vegetable ghees and butters' which would then be nearly, though not quite, as good as butter or ghee.

Fats are needed by the body to provide energy and vitamin A, to make the tissues firm, to prevent loss of heat by the body, to fill out its contours thus adding to its beauty, and to protect certain delicate organs like the kidneys from injury, and also for the following purposes: (1) To help the body to use *calcium* which, as we have learnt in Lesson V, is one of the most important of the mineral body-building materials. If there are not enough fats in the food then calcium is not properly absorbed from the intestine. (2) To protect the velvety lining of the stomach and intestines from injury by harmful substances which may be produced in them when the food is not of the right kind. This the fats can do because of their greasy nature and of the soapy substances which are formed from them in the bowels. Thus, if the food contains too much carbohydrates, acids may be formed from them which may injure the lining of the bowels and cause diarrhœa unless enough fats are present to prevent this happening. (3) If the food does not contain enough fats there is a tendency for the feet and legs to swell because water accumulates in them causing a condition called *œdema*, which is very common in India amongst people whose food contains little or no animal fats. (4) Lastly, fats, especially animal fats, contribute their share in keeping the body protected

against infection by microbes. This they do not only because they contain vitamin A but also because of their nature as fats.

It will be seen from the **food-star** that the amount of fats we need to take with the food is not so great as the amount of carbohydrates. More fats are needed during infancy and childhood than in later life. Too much fat in the food may cause indigestion and constipation; and because it is not burnt up in the body it collects in the tissues and under the skin causing an unhealthy stoutness known as obesity.

Vitamins A and B as well as iodine and carbohydrates are necessary for the proper burning up of fats by the body.

LESSON VIII

The Carbohydrates. These are the second great class of **fuel foods.** They include **starches** and **sugars** of every kind. Examples of starches are rice, white flour, atta, tapioca and sago; examples of sugars are jaggery or goor, brown sugar, white sugar and honey.

A small amount of carbohydrates occurs in liver, kidney, fish roe, shell fish and cheese. Milk contains about 5 per cent in the form of milk-sugar. But apart from these animal sources we get all our starches and sugars from vegetable foods: the former chiefly from cereal grains and the latter chiefly from fruits.

The foods containing carbohydrates are arranged in order of value, from those containing most to those containing least, in the following nine classes:

(1) White and brown sugars, jaggery or goor and honey.

(2) Sago and tapioca.

(3) All cereal grains: rice, ragi, maize, barley, wheat, oats, cholam and cambu.

(4) Dried fruits.

(5) Dhals and grams.

(6) Soya bean, nuts and seeds, dried peas and beans.

(7) Potatoes, garlic, yams and fleshy roots, parsnips onions and other root vegetables.

(8) Fresh fruits.

(9) Green leafy vegetables.

As with every other ingredient of our food—proteins, fats, mineral salts and vitamins—so with carbohydrates: it is best to mix the sources from which we obtain them. It would not be wise to use jaggery or sugar as their chief source, because these foods are too concentrated and too much of them is harmful. Nor could we, with comfort to ourselves, obtain all the carbohydrates we need from vegetables and fruits because we should have to eat a large amount of them and our stomach and intestines are not designed by Nature to receive and deal with so much vegetable food. Nor can we rely on such foods as peas, beans, dhals and grams as the chief source of our carbohydrates because we should then be taking too much proteins, which would go bad in our bowels and do us harm. So a mixture of all the classes of carbohydrate-containing foods given above is best, both from the point of view of carbohydrates and of the other ingredients of our food, especially proteins, mineral salts and vitamins.

All the cereal grains—oats, wheat, rice, ragi, cholam, cambu, barley and maize—are made up for the most part of **starch**, though they also contain some proteins, fats and mineral salts. They are all of about equal value as **fuel foods** and energy-producers. The carbohydrates of fruits are chiefly **sugars**. If we eat plenty of fruit we need take very little sugar with our food.

The carbohydrates are the most economical and the cheapest of all the ingredients of the food, and they form the great bulk of it. Besides being necessary as fuel for the production of energy and heat, carbohydrates

enable the body to make proper use of the proteins and fats in the food. When the food contains all five essential ingredients—proteins, fats, carbohydrates, mineral salts and vitamins—in proper amount and proportion one to another then the carbohydrate part of it is easily and completely digested, and none is left over in the intestines. But when there is too much carbohydrate in the food, which is a very common fault of Indian diets, a lot is left over in the intestine, where it ferments and produces gas and irritating acids. This may result in flatulence, indigestion and diarrhoea.

Too much carbohydrate-containing food-stuffs such as rice, may prevent other essential ingredients of the food, such as proteins, vitamins and mineral salts, from being properly absorbed; and if diarrhoea is set up these important substances may be passed through the body before it can make proper use of them. The result of this may be loss of weight and a greatly increased susceptibility to infectious diseases such as cholera. People whose diet consists almost wholly of rice are very likely to suffer in this way; while people who over-eat and whose food contains much starch and sugar become very fat. Diets which contain much carbohydrates also tend to cause decay of the teeth, as we shall learn in Lesson XX. The habit of eating largely of rice and sweetmeats, is, with bad teeth and want of sufficient exercise, the most common cause of diabetes amongst well-to-do people in India.

Vitamin B is necessary for the proper utilization of carbohydrates by the body.

LESSON IX

The Vitamins. Though these substances are essential to life, and are **builders** of our bodies, we cannot—as yet—make them nor see them nor weigh them, as we can make, see and weigh the other constituents of our food: the proteins, the fats, the starches, the sugars, the mineral salts and water. Now supposing we take these other constituents of food, weigh out the right amounts of them, mix them together and give the food-mixture to young animals they will not grow nor live. But if to this food-mixture we add even a little milk the animals will grow and flourish. There is 'something' in the milk which gives *life* to the food-mixture, enabling it to support the life of the animals and to let them grow. This 'something' is **vitamin**: so-called because it is essential to life. But if we subject this small amount ot milk to *great* heat while exposed to the air, or treat it in various other ways before we add it to the food-mixture then also the animals will not grow nor live. The great heat, or other treatment, *kills* all the vitamins in the milk and so the food-mixture is rendered lifeless. Now supposing we do not heat the milk so much, but when heating it we expose it to the air, and then we add it to the food mixture, again we find that the young animals do not grow and that their eyes or lungs or bowels become diseased. This is because the lesser heating in the air

has not killed *all* the vitamins in the milk but only *one* of them called '**vitamin A**'.

If we take paddy, fresh from the rice-fields, husk it and give it, with water, as food to pigeons they will remain well. But if the paddy be sent to a rice mill, where it is turned into white, polished rice, and then it be given with water to the pigeons they will lose their appetite, become very thin, suffer from diarrhoea, get paralysed, and die. The milling and polishing has *removed* from the rice 'something' which is necessary to the life and health of the birds. This 'something' is a vitamin called **vitamin B.** If now we give the rice polishings to the pigeons in addition to the white polished rice they will remain well, or if the white rice has made them ill the polishings will enable them to recover. But if we mix soda with the polishings, subject them to great heat, and then add them to the white rice the birds will again become ill and die. This treatment *kills* 'something' in the polishings; this something is **vitamin B.**

Again, supposing we live on foods such as salted meat, white bread and *dried* fruits and vegetables, or if we feed guinea-pigs on dried oats and boiled milk, then we and they will become ill and suffer from a disease called **scurvy.** In this disease the gums are sore and bleed, the legs swell and are painful, a rash appears under the skin due to the blood collecting there, and men or animals suffering from it often die. But if to these foods we add the juice of lemons, oranges or other fruit or green leaves, then scurvy is prevented and those who suffer from it are cured. This is because

these fruit juices and green leaves contain another vitamin called **vitamin C.** But if we boil the juices, or treat them in certain other ways, then scurvy will not be prevented nor cured because this vitamin is *killed* by boiling.

Again, if children, living in dark and gloomy houses into which the sunlight does not penetrate, do not receive enough milk, butter, ghee or cod-liver oil in their food, then they become restless, irritable and cry a great deal, their bones become soft and bent and their muscles and joint flabby, causing a disease called **rickets.** This is because their food does not contain enough of another vitamin named **vitamin D.**

If rats be given a food which does not contain lean meat, whole wheat or certain kinds of vegetables then no young ones are born or if they are born they are not properly made and soon die. This is because the food of the parents did not contain another vitamin called **vitamin E.**

These are all the vitamins we know of at presentt and this is how they have been discovered. But there may be many of them still remaining to be found. It does not greatly matter to us how many vitamins there are provided we remember that all the vitamins we need are present in the foods which Nature supplies for our use, and *provided we eat them as Nature supplies them and do not spoil them by removing the vitamins from them or by killing the vitamins in them before we eat them.* Now the foods which Nature provides for our use are these :

1. Milk and the things we make from it: butter, ghee, sour milk, buttermilk, curds, whey and cheese.
2. Animal foods: flesh meat, liver, kidney, brain, sweetbreads, poultry, fish and eggs.
3. Animal fats: such as mutton fat and goat fat.
4. Vegetable oils: gingelly, mustard, almond, linseed, cocoanut, olive, ground-nut and cotton-seed oils.
5. Cereal grains of all kinds: wheat, rice, barley, maize, cholam, cambu and ragi.
6. Tuber and root vegetables of all kinds: potatoes, artichokes, yams, carrots, parsnips, beetroot, onions, turnips and all edible fleshy roots.
7. Dhals, peas and beans.
8. Nuts and seeds of all edible kinds.
9. Green leaves of all edible kinds.
10. Fruits and berries of all edible kinds.

We must now learn how the different vitamins are distributed in these different classes of food-stuffs and what illnesses are likely to arise if our food does not contain enough of them.

LESSON X

Vitamin A. This vitamin is made by the action of sunlight on the green leaves of plants. Animals do not seem to be able to make it for themselves; they can only get it by eating plants or the fat and organs of plant-eating animals. The young leaves and shoots of growing plants contain most of it; but some is also present in their seeds because it is needed for the growth and development of all young things, young plants as well as young children. When animals eat plants containing vitamin A it goes into the fat of their bodies where it is dissolved and stored; it is also stored in the liver, kidneys and other organs, but principally in the liver which is a very rich source of this vitamin for man. It is passed into the milk of animals who suckle their young because their young need plenty of it. Cows fed on food that is not green, or on dried and parched grass, do not get enough vitamin A; so they become of poor condition themselves and their milk contains little of this vitamin. Such milk is not the best for young children. In the same way it is very necessary that mothers should eat green vegetable and other foods containing vitamin A; for if they do not their children are weak at birth, and during infancy, while they are dependent on their mothers, they will be very prone to illness and may die in consequence. One of the reasons why so many children in India die in infancy is because their mothers do not eat the right kind of food containing plenty of vitamin A.

Birds need green food just as much as we do both for their own health and that of their young. Vitamin A is stored in the yolk of eggs in order that the developing chick may have plenty of it and be strong when hatched. Eggs are, therefore, another rich source of this vitamin for man.

Vitamin A is also made by the action of sunlight on certain small plants living on the surface of the sea or in ponds, lakes and rivers. By eating these little plants fish get the vitamin A they need and store it in their fat, liver and eggs or roe. So when we eat fish or fish-liver oil or fish-roe we get vitamin A from them. It is also produced when grains are sprouted after soaking in water ; sprouted dhals and gram contain quite a lot of it.

Because this vitamin is made by the action of sunlight on the leaves of plants there is not so much of it in tuber and root vegetables which grow under the ground, though a little of it is passed to them from the leaves and stored in their fatty parts. Yellow root vegetables, such as carrots and sweet potatoes, contain more of this vitamin than white or red ones such as potatoes, turnips, beetroot and radish.

This vitamin is needed for the growth and repair of the body : it is, therefore, very necessary for children, though adults need it also for the repair of worn out parts of their tissues. It is needed also to keep the blood of proper composition, to prevent water collecting in the tissues, and especially to protect the body from infectious diseases.

There are, as everyone knows, certain small organisms called 'microbes' which cause disease. Now the only

way the microbes can get into our bodies and do us harm is through cuts or injuries to our skin, or through the velvety membranes—called *mucous membranes*—which line the inside of the eyelids, the mouth, the nose, the wind-pipe, the stomach, the bowels and the bladder. If the skin be healthy and clean microbes cannot grow upon it, nor get through it unless by such means as the bites of insects: mosquito-bites may cause malaria, lice-bites may cause typhus fever or relapsing fever and sand-fly-bites other fevers. Nor can microbes grow upon or get through the mucous membranes if these be healthy and clean any more than rain can get through the well-built roof of a house. The great way in which these membranes are well-built and kept in good repair is by good food containing plenty of vitamin A. When there is not enough of this vitamin in the food then one or more of these mucous membranes lose their vitality and microbes are able to grow upon them or to get through them into the body. This is one of the ways in which a great many different kinds of disease are produced, such as inflammation of the eyes, ears, nose, throat, lungs, stomach and bowels. It is for the same reason that the bladder may become diseased and stone develop in it. Even the inside of the eye may go wrong and people be unable to see in the dusk. This trouble, called 'night-blindness,' is common in certain parts of India. So good food containing plenty of this vitamin is a great protection against these diseases, all of which are very common in India.

Ordinary cooking does not destroy vitamin A to any great extent. It is only destroyed when the cooking is

prolonged and if the food be exposed to the air during cooking.

Whole rice contains some, but not much, vitamin A. What it does contain is removed when rice is milled and polished, or is destroyed when rice is parboiled. In parboiling, steam is passed through the paddy which is then spread out on earthen or concrete floors to dry. The exposure of the moist, heated rice to the air kills the vitamin A it contains.

The common food-stuffs are arranged in order, from those containing most vitamin A to those containing least or none at all, in the following five classes :

1. **Foods rich in vitamin A :** Liver oils, cod-liver oil, fish oils, fat fish (mackerel, herring, sardines, etc.), fish-roe, egg-yolk, butter or ghee, liver, kidney, mutton and other animal fats, whole milk and palatable green leafy vegetables such as spinach, watercress, lettuce, celery leaves, cabbage, turnip tops, beetroot tops, radish tops, bamboo tops and lucerne grass tops.
2. **Foods less rich in vitamin A :** Yellow root vegetables such as carrots, sweet potatoes, tomatoes, yellow maize, sprouted gram, linseed and millet (ragi).
3. **Foods poor in vitamin A** but containing some : Skimmed milk, dhals, gram, peas, beans, wheat, cholam, cambu, oats, barley, rape seed, sun-flower seeds, chillies (red and yellow capsicum), palm kernel, cocoanut oil, margarine containing animal fat, soya beans and orange juice.

4. **Foods containing very little vitamin A:** Lean meat, honey, whole rice, onion, potato, beetroot, turnip, parsnip, radish, bananas, nuts, ground-nut oil, olive oil, gingelly oil, cotton-seed oil, linseed oil and lard.
5. **Foods containing no vitamin A:** White flour, polished rice, parboiled rice, mustard oil, almond oil, cocoanut-butter, vegetable margarine, cocogem and 'vegetable ghees.'

If the food be made up of the substances mentioned in the last four classes it will not contain enough vitamin A for the best growth of children nor for their continued good health; but with the addition to the food of whole milk or butter or ghee or liver or eggs or fish oils *and* green leafy vegetables plenty of this vitamin will be provided.

The chief illnesses which may be brought about by want of vitamin A in the food are: stunting of growth, inflammation of the eyes, night-blindness, 'colds,' inflammation of the lungs, such as pneumonia, broncho-pneumonia and tuberculosis, and inflammation of the bowels, such as diarrhœa and dysentery, dropsy and stone-in-the-bladder. Vitamin A is one of the things in food which helps to keep the skin healthy; vitamins B and C and suitable protein also help to do so.

LESSON XI

Vitamin B. This vitamin is made by plants from substances which they extract from the soil and air. The kind of soil and the way it is manured and watered have much to do with the amount of vitamin B the plants contain. It occurs chiefly in the seed or fruit of the plants, though it is also present in their green leaves. When these parts of plants are eaten by animals and by man the vitamin B is absorbed into their bodies and used for their growth and repair as well as for the various processes of digestion, the discharge of waste materials from the body and the proper action of the muscles, nerves and skin. Most of it goes to those parts of the body that have most work to do in ministering to other parts. It is, therefore, plentiful in the brain, the heart, the liver, the kidneys and the digestive organs. These parts of animals, when used as food by man, are rich sources of vitamin B. Like vitamin A it is passed into the milk of animals who suckle their young; so it occurs in the milk of buffaloes, cows, and goats, provided their food contains enough of it. It passes also into the eggs of birds because it is needed for the development of their young: milk and eggs are, therefore, rich sources of this vitamin for man. The food of mothers must contain plenty of vitamin B otherwise their infants may not get enough of it and may become ill in consequence.

It does not occur in any fats or oils whether of animals or of vegetable origin; nor in white sugar, though a little is present in brown sugar or jaggery (goor) and in honey. The great sources of it are:

1. Cereal grains: Wheat, barley, maize, cholam, cambu and ragi.
2. Pulses: Peas, beans, dhals and gram.
3. Nuts of all kinds.
4. Green leafy vegetables, such as spinach, turnip tops, lettuce, watercress, and tomatoes.
5. Milk, eggs, liver and other glandular parts of animals.

Yeast and certain preparations of yeast also contain a great deal of vitamin B, but these are not used as food in India nor are they needed if the food be chosen wisely.

It is upon cereal grains—the **staple articles** of our diet—that we depend mostly for vitamin B. If we eat these grains as Nature provides them then we get plenty of this vitamin. But very often we do not eat them until they have been treated in various ways which remove the vitamin from them.

Millions of people in India live on rice. Some pound it for themselves to remove the husk before using it, others send it to mills to be made into white rice, others have the rice parboiled first and milled and polished afterwards, while others buy their rice in the bazaar. Of all the grains used in India rice is the poorest in vitamin B. The vitamin is located in the outer layers of the rice grain. When rice is milled and polished, these outer layers are removed and with them most of its vitamin B.

48151

When rice is parboiled before milling the outer layers stick to the grain and are not so easily removed. Parboiling is, therefore, a good thing in some ways. But it is bad in other ways: the parboiling destroys any vitamin A the rice contains; and since parboiled rice is always dirtier than white rice it has to be washed in many changes of water before it can be used as food. Now vitamin B dissolves in water so the washing of parboiled, or any other rice, dissolves the vitamin B out of it and this very important constituent of the food is lost when the rice-water is thrown away. By far the best way to use rice is to pound it at home, and to wash it as little as possible after pounding. The water in which it is washed should not be thrown away but should be drunk by the family in the same way that the water in which vegetables are boiled should not be thrown away but be used by the family. Even by using rice in this way there is not enough vitamin B in it for the needs of the body, so other foods containing it *must* be eaten with it. As a rule some kind of dhal is used, but often not enough. The amount of dhal to use with rice is about one part of dhal to every 5 or 6 parts of rice; but not more than 4 to 5 ounces of dhal a day should be eaten, for more than this goes bad in the bowels. If only about one ounce of dhal a day is eaten with white polished rice, or if no dhal at all is used with it, then a disease called **beri-beri** is very likely to arise. This is an illness in which the limbs become paralysed and swollen out with dropsy, and the heart is diseased. It is very common in certain parts of India where the people grow little other

food but rice and eat little else. Everyone who grows rice for his own use should always keep a certain part of his land for growing other things as well: such as tomatoes, pulses, ground-nuts and green leafy vegetables like spinach, turnips, radishes and lettuce. By doing this he will have other foods containing vitamin B to eat with the rice and his own health and that of his family will be much better especially if they take milk and milk-products as well. The best of all vegetables to grow and to eat with rice are tomatoes. Vitamin B is often called the *anti-beri-beri vitamin* because it prevents beri-beri, but it must be remembered that it does much more that this and that it is one of the chief things which keeps the body well.

When wheat is ground at home (as people do in the Punjab) and made into chapattis then there is plenty of vitamin B in the food. Some races use both rice and wheat: this is an excellent thing to do, for rice is a very good food when eaten with wheat, milk and vegetables. But in Western countries the wheat is made into *white flour* because it keeps better in this form and is nicer to look at. In making it into white flour the wheat loses most of its vitamin B, just as rice does when it is milled and polished. It also loses the best of its proteins and a great part of its mineral salts. For these reasons the bread made from white flour, even when made with yeast, is not nearly so good as bread or chapattis made from whole wheat flour (*atta*.)

Grains like cholam, cambu and ragi are usually ground up and eaten in various ways which do not deprive them of their vitamins nor of their mineral

salts and proteins. So ragi-eaters and atta-eaters are usually stronger and healthier than rice-eaters; they must, however, take milk, butter, ghee or fish oil to provide enough vitamin A, otherwise they may get stone-in-the-bladder or other illnesses.

Vitamin B is needed by the body for its building and repair, as all other vitamins are in one way or another. But it has special work to do also; (1) it keeps the brain and nerves healthy and strong; (2) it keeps the heart, the liver, the digestive glands and the kidneys healthy and strong; (3) it keeps strong the muscles of the body, including those of the bowels; and (4) it maintains the appetite and the digestion. When the food contains plenty of vitamin B it is not only eaten with relish but digested properly and waste materials are discharged properly from the body. If any vitamin can be said to be more important for health and well-being than another, it is vitamin B. When the food does not contain enough of it there is a distaste for food or a taste for unhealthy things; indigestion, diarrhoea, or constipation and pain in the belly may occur; the muscles are weak and the nerves irritable; resistance to infectious diseases is lowered; and, beri-beri may arise.

Ordinary cooking does not destroy vitamin B; but much washing of food, as of rice, dissolves it out so that it may be lost in this way. If vegetables are boiled, especially when soda is added to the water, as some people do when cooking peas or beans, then the vitamin may be destroyed. But the chief reasons why so many people in India do not get enough vitamin B

are these : (1) they use polished rice or white flower as their staple article of food; and, (2) they do not eat enough other foods containing vitamin B.

The common food-stuffs are arranged in order, from those containing most vitamin B to those containing least or none at all, in the following four classes :

(1) **Foods rich in vitamin B**: Yeast, egg, liver, tomato, celery, walnuts, asparagus, lettuce, spinach, turnip tops, radish tops and watercress.

(2) **Foods less rich but containing much vitamin B**: Wheat (*atta*), barley, maize, cholam, cambu, ragi, oats, oatmeal, beans, peas, dhals, gram, soya bean, linseed, nuts of all kinds, beetroot tops, cabbage, carrots, dandelion, lucerne grass, clover, mushroom, onion, parsley, turnips, swede, brain, heart, kidney and milk.

(3) **Foods poor in vitamin B**: White bread, whole rice, parboiled rice, artichokes, bamboo shoots, bananas, beetroot, egg-plant (brinjol), potato, yams, radish, sweet potatoes, grapes, dates, lemons, limes, oranges, papoya, pears, prunes and lean meat.

(4) **Foods containing no or very little vitamin B**: White flour, polished rice, butter and all animal and vegetable fats and oils, custard powders and egg-substitutes, mangolds, beet-sugar, cheese, sugar, starch, old peas and beans, tinned meat, tea, coffee and honey.

The food will contain an abundance of vitamin B if it consists *of any whole cereal grain*, milk or egg, or liver, or dhal, tuber and root vegetables, tomatoes and green

leafy vegetables. Diets to suit all races, castes and religions can be arranged from the above four classes of food-stuffs which will contain plenty of this essential vitamin.

LESSON XII

Vitamin C. This vitamin is also called the *anti-scorbutic vitamin* because it is necessary for the prevention of **scurvy** : a disease very common in India.

Vitamin C occurs plentifully in all fresh green vegetables, in edible green leaves and in most fresh fruits, though some contain more of it than others. It is not present in the seeds of plants such as rice, barley, wheat, maize and nuts. But when grains are moistened in water and allowed to sprout the sprouts then contain it. This is a very good way to obtain vitamin C when green vegetables and fruit are scarce.

Dhal, gram, wheat, unsplit peas or any other grain is first soaked in water for 24 hours and is then spread out on damp earth or on a damp blanket and covered over with a moist cloth or sack (gunny bag) which is kept moist by sprinkling water upon it from time to time. After two or three days the grains will have sprouted and be ready for use.

The sprouted grains should be eaten raw or after cooking for not more than two minutes; they also contain vitamin A (Lesson X).

When fresh vegetables and fruit containing vitamin C, are eaten by animals the vitamin is absorbed into the body where it is present in the blood and liver. Flesh-eating animals, such as tigers and leopards, obtain the vitamin C they need from the blood and liver of animals they kill and eat. So also do flesh-eating races

like the Eskimos. Very little vitamin C is contained in the flesh of animals and to obtain enough from this source the flesh has to be eaten raw. The vitamin is passed into the milk of animals who suckle their young, and is, therefore, present in the milk of buffaloes, cows and goats provided they are fed on fresh green grass or leaves. If they are fed on dried up grass their milk contains little vitamin C, and then it is not good for infants. Milk does not contain as much vitamin C as the same amount of fruit-juice. To obtain enough vitamin C from milk alone a boy or girl would have to drink three or four pints of fresh milk a day.

Vitamin C does not occur in any animal or vegetable fats such as butter, ghee or gingelly oil, nor in any *dry* food, such as dried vegetables, sugar, white flour, atta or rice. It is easily destroyed by heat as when milk or vegetables containing it are boiled, especially when exposed to the air. The longer the time of cooking the more surely is it destroyed. If soda be added to the water in which vegetables are boiled it is destroyed more quickly still. Of all the vitamins, C is most easily destroyed by heat; this is very important in India where milk is usually boiled before it is given to children. Infants reared on boiled milk will certainly become ill unless they are also given the juice of fruits, such as oranges or tomatoes, or vegetable juices, such as swede juice, to provide vitamin C. It is a good rule to give all infants plenty of such juices.

Vitamin C is needed by the body (1) to keep the blood pure and of proper composition, and to prevent it leaking out of the blood-vessels; (2) to help the

other vitamins in the building of the body, especially the bones and teeth; (3) to help in keeping the bowels healthy; and, (4) to help the body to resist infection by microbes. It is not necessary that the illness called scurvy should appear before we know that we are not taking enough vitamin C with our food; for many signs of ill-health are present long before bleeding from the gums appears. We may lose our appetite, be pale, anaemic, short of breath, lazy and irritable and lose weight or not gain in weight; the heart may beat too quickly; the gums may be spongy and unhealthy looking, the teeth bad and the breath offensive; the joints may ache; the ankles may swell and the legs be painful and sensitive to the touch. Infants who suffer in this way—and many do—cry a great deal when they are handled because their bodies are painful. It is very important, therefore, that infants fed on boiled milk should be given fruit and vegetable juices and that all older children should take raw green vegetables and fresh fruit in their food. Young children cannot be given raw vegetables unless they are finely minced; the best way to give them is in the form of vegetable juices.

The common food-stuffs are arranged in order from those containing most vitamin C to those containing least or none at all, in the following four classes:

1. **Foods rich in vitamin C.** Fresh raw cabbage, spinach, sprouted peas or dhals or gram, swede juice, fresh lemon juice, orange juice, tomatoes and tomato juice.

2. **Foods less rich but containing a good deal of vitamin C.** Fresh young carrots (raw), lettuce, watercress, turnip tops, celery, raw potato, fresh green runner beans, juice of sweet potato, vegetable marrow juice, sprouted beans, sprouted peas, orange peel, peaches and peach juice, pine-apple juice, prickly pear and cold infusion of fresh pine needles.
3. **Foods poor in vitamin C.** Milk, skimmed milk, buttermilk, curds, sprouted barley, sprouted cholam, sprouted oats, fresh young corn-cobs, beetroot, cooked cabbage, raw carrots, boiled cauliflour, dandelion, endive, mangold, onion, cooked potato, water melon, rhubarb, turnips, apples, pears and bananas.
4. **Foods containing no or very little vitamin C.** Lean meat, eggs, soya beans, oatmeal, wheatmeal (*atta*), white flour, cholam, ragi, cambu, maize, barley, dried peas, beans, dhals and gram, sugar, honey, yeast, vegetable oils, animal fats, dried fruits of all kinds, dried vegetables of all kinds, nuts of all kinds, tinned fruits (unless first soaked in salted water for a few hours before tinning), tinned milk, dried milk and all dried infant foods sold in tins.

It is not to be understood that 'foods poor in vitamin' are of no use to us; they are of use, but to get enough of this vitamin from them we have to take a good deal of them. Thus we should have to take 3 or 4 pints of milk, two pounds of turnips or grapes, nearly a pound of carrots, half-a-pound of apples, bananas or

potatoes, and three ounces of fresh limes to get as much vitamin C from them as we can get from one ounce of lemon or orange juice, or from three-quarters of an ounce of fresh raw cabbage leaves. Many of our vegetables such as potatoes, carrots, cabbage and cauliflour are cooked before we eat them so as to improve their digestibility. The cooking destroys the vitamin C either wholly or in part. In the first three classes of vitamin C-containing food-stuffs there are many vegetables that can be eaten raw with good appetite; the food should always contain a fair proportion of them to provide the vitamin C which the body needs in considerable quantity.

Besides preventing scurvy it must be remembered that an abundant supply of vitamin C is necessary to keep the blood pure, the teeth in good condition and the bowels healthy.

LESSON XIII

Vitamin D. This vitamin occurs in milk, butter, ghee, yolk of egg and fish oils. Cod-liver oil is very rich in it. A little is also present in cocoanut oil and peanut oil, but none, so far as we know, in any other of the vegetable oils which are used in India. Vitamin D can also be produced by the action of the sun's rays on the skin. Vegetable oils, such as gingelly oil, which contain none of this vitamin, should be exposed to the sun in a shallow vessel before they are used as food. In India many people are accustomed to rub the body over with oil while standing in the sun: this practice is a very good one because vitamin D gets into the body in this way.

When there is not enough of this vitamin in the food, or when the body, or part of it, is not sufficiently exposed to sunlight, the bones of young children are not properly made and they become soft, and bend, causing the disease called **rickets.** In older persons the same thing may happen causing a disease called **osteomalacia** (softening of the bones). Rickets is a very common disease in Europe and America because there are so few foods in which this vitamin occurs plentifully, and because bright sunlight is scanty or children live so much in dark and sunless houses. It is much less common in India because children run about so much in the sun. But sometimes rickets occurs in children, and osteomalacia in young women, living under the purdah

system in dark rooms from which the sunlight is excluded. For this reason, if for no other, the purdah system is a bad one. There is little sunlight in the Arctic regions yet Eskimo children do not suffer from rickets : this is because the food of their mothers includes fish oils, and because the children themselves take these oils when they are older.

In other Lessons we learnt that rickets may arise if the food does not contain enough calcium and phosphorus or if these mineral elements are not present in the food in the right proportion one to another. Now we see that rickets may also occur if the food does not contain enough vitamin D or if the body does not get enough sunlight. It is easy to understand why rickets can be caused in these different ways. If the food does not contain enough calcium or phosphorus or if it cantains too much phosphorus and too little calcium then there are not enough **building materials** to make the bones. Even when there are enough building materials the **builders**—vitamin D and sunlight—may be absent or scanty and so the building materials cannot be properly used.

Children whose food is too poor in vitamin D are nervous, cross, restless, and sleep badly. Their muscles and joints are slack and their bones are soft. So they cannot stand or walk as early in life as healthy children. The muscles of the bowels are also slack, so such children are constipated and their bodies bulge in front. When they do begin to stand and try to walk the bones bend because they are so soft and the children become bow-legged or knock-kneed, or their arms and spines

become crooked. Their blood is poor and they look pale and pasty (anaemic). Many have 'fits' (convulsions), and all are very prone to catch 'colds' and diseases of the lungs. Even if they survive their bodies are dwarfed and stunted. Children who live in India and enjoy so much sunlight are very fortunate in so often escaping an illness to which children in less sunny lands are so subject.

Want of sufficient vitamin D in the food is also *one of the causes* of bad teeth and of their early decay. But as there are many causes of bad teeth and as it is so important to our health to have good ones and to take proper care of them, we shall devote another Lesson to learning more about them (Lesson XX).

Remembering what we have learnt in previous Lessons about the distribution of the various vitamins in the food-stuffs provided by Nature for our use, we now know that we can obtain them all from comparatively few foods: cereal grains, milk, liver, egg, fish, fresh fruit and green leafy vegetables. Now, no matter what our staple food grain my be—rice, wheat, barley, maize, cholam, cambu or ragi—our food will always contain enough vitamins, as well as enough 'suitable protein,' mineral salts, fats and carbohydrates, if with it we take milk and its products, egg or liver or fish, fruit, and green leafy vegetables. If we can get enough milk then we can do without meat or liver or fish provided we eat plenty of fruit and green leafy vegetables. Milk, eggs, fruit and green leafy vegetables are thus very important parts of our food because they contain all the things—proteins, mineral salts and vitamins—in

which the other ingredients of the diet are poor. For this reason they have been called the 'protective foods': they protect us from illness caused by want of the essential proteins, mineral salts and vitamins.

LESSON XIV

Milk is the best of all foods for human beings and mother's milk is the best of all milks for infants. It is best because it contains everything the infant needs for its proper growth and development, in just the right amounts—proteins, fats, carbohydrates, mineral salts and vitamins—neither too much of them nor too little. But it is very necessary that the mother's food should be such as will provide in her milk everything the baby needs otherwise the child may suffer and become ill. So her food, in addition to the staple food-grains (rice, wheat, cholam, ragi, etc.) to which she is accustomed, should contain also milk and milk-products and plenty of green leafy vegetables and fruit. If she is a purdah woman she should also take a little fish oil or cod-liver oil each day, provided her religion permits her to do so, or she should bask in the sun each day and take an oil bath occasionally. Infants should always be given water between feeds.

Cow's milk. For older children and adults, cow's milk is the most valuable of all foods. Its proteins are of the highest quality, and are 'suitable' additions to those of the cereal grains which are of the 'less suitable' kinds. This is one reason why milk is the best of all foods. It is rich in **fats** (butter and cream) and if the cows are properly fed it should contain an abundance of **vitamin A**—a vitamin most necessary for growing

children and for protection against diseases due to microbes. The fats of milk are easily digested. It contains about 5 per cent of carbohydrates. It is rich in **calcium** and **phosphorus** which are both so necessary for the proper growth of bones and teeth. These mineral elements are also present in milk in the right proportion; not too much phosphorus nor too little calcium. It is poor in **iron**, but this does not greatly matter even for infants who are reared on cow's milk, because the child is born with enough iron in its body to last until it is through the nursing period; when it begins to take other foods besides milk it can get plenty of iron from those foods which are rich in iron (Lesson VI). Cow's milk also contains **vitamin B**; though if milk be the only source of this vitamin in the food a quart at least would have to be taken each day to provide enough of it. Cow's milk does not contain much vitamin C, though enough if the milk be not boiled; and since it must always be boiled in India it is best to regard cow's milk as containing no vitamin C. When infants are reared on boiled milk they must always be given fruit and vegetable juices to make up for the vitamin C destroyed by boiling the milk. Tomato juice is one of the best juices to use for this purpose. Cow's milk contains some **vitamin D** but not enough for young children reared upon it; they must, therefore, have plenty of sunlight or if they cannot get sunlight they must be given 20 or 30 drops of cod-liver oil to provide vitamin D otherwise they will be likely to get rickets. When milk forms only a small part of the food of children it will not in itself

provide enough vitamins to make up for their deficiency in the rest of the food.

The amount of vitamins in cow's milk depends on how the cows are fed. If they are given plenty of green food and live in the open air and sunlight then the vitamins in their milk are plentiful, but if they are fed on dry food and kept indoors their milk is poor in vitamins of all kinds. The same applies to nursing mothers.

Milk from which the cream has been removed—**skimmed milk**—is good for the growth and health of children because it contains most of the suitable proteins and most of the vitamin B, as well as about 10 per cent of the vitamin A present in whole milk.

Buttermilk and curds are also very good: both contain the proteins of milk; the former is very refreshing.

Microbes grow quickly in milk. Not only do they spoil it, but many of them are harmful. This is one of the most common causes of diarrhoea and inflammation of the bowels in infants. Milk must always be boiled before use. The boiling kills the harmful microbes.

One of the best ways to use milk in India is to turn it into **sour milk**. The sour taste is due to *lactic acid* which is produced in the milk by certain harmless microbes. If the milk be soured before harmful microbes have time to grow in it, it is very wholesome and keeps good much longer than unsoured milk, because the harmless microbes prevent the harmful ones growing. In warm climates like that of India sour milk is more digestible than fresh milk and is more

refreshing. It promotes physical well being and long life. Wherever sour milk is used freely as a staple article of the diet the people using it are exceptionally strong and long lived.

Buffalo milk contains more proteins and twice as much fat as cow's milk. It is an excellent food; it is largely used in India for making ghee.

Goat's milk and sheep's milk contain more protein and fats and slightly more vitamins A and D than cow's milk; they are very excellent foods. If the breed of goats and their milk-yielding capacity were improved throughout India, as has been done in some places, it would be of very great benefit to the people.

Cheese is hardened curd of milk. When made from whole milk it contains most of the milk proteins and fats and a good deal of the calcium and phosphorus. It is very rich food and not much of it should be eaten at a time. But a little cheese is good to supplement the 'less suitable' protein of cereal grains.

Butter contains all the fats in milk and most of the vitamin A. It is the most easily digested of all fats. It contains neither vitamin B nor vitamin C and only a little vitamin D. Some butters contain more vitamin A than others depending on the food of the cows and buffaloes. Yellow butter contains more vitamin A than white butter.

Ghee is butter that has been boiled. Butter is made into ghee in India because it keeps better and does not go rancid so soon. If the butter be boiled in open vessels exposed to the air the vitamin A in it is likely to be partly or wholly destroyed. It should be boiled

in closed vessels and kept as much as possible away from the air. One of the great difficulties in India is to get enough vitamin A, so care should be taken, when making ghee from butter, not to destroy the vitamin A the butter contains. Ghee is often much adulterated with animal fats (*charbi*) and vegetable oils, and owing to the lack of care in its preparation it is often very dirty and goes bad quickly.

The greatest nutritional need of India at the present time is the production of more and of purer milk, for there is no more important food-stuff than this and none on which the public health is more dependent. The conditions under which milk is produced and sold in India are often filthy in the extreme; its adulteration with impure water is a universal practice; the cream is commonly removed to make butter and ghee before the milk is sold, so that the milk available to the people is not only skimmed milk but adulterated skimmed milk and dirty skimmed milk; no proper attention is paid to the feeding of the cows and buffaloes nor to their hygiene, and in consequence the milk, and the butter or ghee obtained from it, are often of the poorest quality and lacking in proper content of essential vitamins. Animals for milk-production are not selected with sufficient care and their yield of milk is almost invariably low. The rising generation must realize the importance of pure milk to the well-being of the people and see to it that India shall become as enlightened with regard to milk-production and to milk-distribution as other countries.

If the food contains enough milk and milk-products then it is not necessary to eat flesh-meat at all. 'Enough'

milk is not less than one pint a day, and a quart if possible; but few children in India consume anything like this amount.

Liver. This is one of the most valuable of all the animal foods available for use by man. It is the great store-house of carbohydrates in the body and of the vitamins—A, B, C and D. It is from the liver of the animals they kill for food that carnivorous beasts (tigers leopards, etc.), and races of mankind who live chiefly on animal food, obtain the greater part of the vitamins they need. It is a particularly rich source of vitamin A: the addition of a little liver oil to vegetable oils will make good the deficiency of the latter; an important thing to remember in a country like India where sources of vitamin A are scarce. The liver of fish and birds is particularly rich in this vitamin; sheep and goat's liver also contains it in large quantity. The proteins of liver are very 'suitable' for use by man. The liver is also rich in manganese—a mineral element which stimulates growth—and in iron which is so necessary for the proper composition of the blood and for enabling it to carry oxygen to all parts of the body. Liver is very rich in fats and contains many other substances which are of great benefit to man. Altogether liver is a most useful food and for those whose religion permits them to eat it, its use in moderate amounts—say, once a week—is very beneficial. Fresh liver extract or pounded liver is a cure for certain kinds of severe anaemia and is very useful in a disease of the intestines called 'sprue.'

Eggs. Next to milk and liver, eggs are the most

valuable of all animal foods. They are very digestible except when they are hard boiled. They contain all the vitamins except vitamin C, and their proteins are of the most suitable kind. White of egg consists of a pure protein, called albumen, in water. Eggs are rich in fats, calcium, phosphorus and iron, which are present principally in the yolk. Though not so good as milk, they are useful substitutes for it when milk is scarce. As they are so rich not more than two or three eggs should be eaten in one day. It is a great pity that in India people do not devote themselves more to the breeding of hens from good egg-laying stock. There is a great opportunity in India for this industry which is one that would bring with it an increase in the health and strength of the people provided they used the eggs as food and did not export them.

Meat. This includes the flesh of animals such as sheep, goats and game, also the flesh of poultry. Meat is rich in 'suitable' protein and is a most useful means of making up for the deficiencies in the protein fragments of the cereal grains. When eaten with the fatty parts of the animal it is a source of animal fats and, therefore, of vitamin A. It does not contain much vitamin B, and when meat enters largely into the dietary it is very necessary to get plenty of vitamin B from other sources, such as *atta* and tomatoes. The more meat eaten the more vitamin B is needed. It contains some vitamin C; but to get enough of this vitamin from meat, red or raw meat has to be eaten. It contains little vitamin D, but some vitamin E. Meat is a stimulating food increasing bodily vigour. It is rich in phosphorus but poor in calcium.

Kidney, brain and **other organs** of edible animals are very good foods. Their proteins are of good quality and they are rich sources of vitamin B. They contain also some vitamin A and vitamin C. Brain is rich in certain kinds of fats, which are very valuable as food, and in phosphorus. Kidney contains a little carbohydrates, and brain two of the rarer mineral elements—copper and zinc—which the body needs in minute amounts.

Fish. Fish is a very valuable food; it is a favourite one in India for these who live near the sea-coast or who can obtain it from rivers, streams and tanks. So important is this food that fish-culture is a pursuit which might well engage the attention of educated Indians. The proteins of fish are of the most suitable kinds for use by man. Fish contains all the vitamins except C; and fish oils, especially those of sea-fish, are a very valuable source of vitamins A and D. Iodine and copper are present in fish.

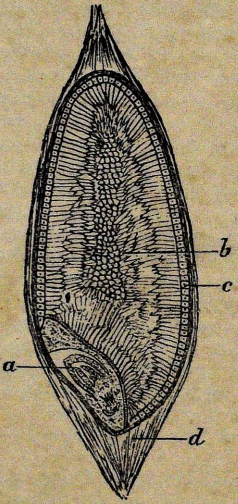
Eggs, meat, liver, kidney, brain and other organs, cheese and fish are all 'acid-forming' foods. This must be balanced by including plenty of vegetables and fruit in the diet so that the blood and body-fluids may remain of the right reaction: neither too acid nor too alkaline.

LESSON XV

Cereal Grains. It is on the cereal grains—rice, wheat, barley, maize, cholam, cambu, ragi, oats and rye—that we rely for the main bulk of our food. They are the cheapest as well as the chief source of **carbohydrates,** which comprise the bulk of the food, and all are about equally good as fuel. But no cereal grain contains, in sufficient amount or kind, all the other things our bodies need besides the carbohydrates, so that we cannot live on cereal grains alone for more than a short time without becoming ill. Some of them, such as wheat and rice, are poor in **fats,** while others, such as oats, cholam and cambu are rich in fats. Some are better than others as sources of **proteins, mineral salts** and **vitamins.** All of them contain proteins of the 'less suitable' or the 'unsuitable' kinds, which are not so well absorbed from the intestines as animal proteins. All contain too little of certain mineral elements (calcium, iron, sodium, phosphorus and chlorine). All are deficient in vitamin, A, C and D; while some, such as polished rice and the white flour made from wheat, are deficient also in vitamin B. All contain plenty of vitamin E.

The cereal grains used by different races in India are those that grow best in the part of India in which they live; and in general it may be said that these are the most suitable grains for them. So they are rice-eaters,

or wheat-eaters, or ragi-eaters, and so on, according to the grain which forms the staple of their national diet. Now it is in proportion to the faults of these various cereal grains and to the way in which these faults are made good by the use of other foods, containing 'suitable proteins', fats, mineral salts and vitamins, that the physical development and well-being of the different races of India depend.



If we cut any of these grains in two, from top to bottom, and look at it under a magnifying glass we find that it is composed of the parts shown in this figure: 'a' is the germ from which the young plant grows. It contains most of the proteins, mineral salts and vitamins that are present in the whole grain, because both 'building materials' and 'builders' are needed for its growth. It also contains a good deal of fat and carbohydrate. 'b' comprises the bulk of the grain. It is made up chiefly of starches with some sugars and proteins, which are intended as foods for the young plant when the grain germinates.

'c' is the bran-coat surrounding 'a' and 'b'. It consists of several layers containing more proteins, vitamins and mineral salts, for the use of the young shoot until it has grown leaves and roots with which to find its own food. Surrounding the whole grain is the husk 'd'.

Now when we use any of these grains we first remove the husk since it is no use to us as food. Then we treat the husked grains in various ways according as they are suitable for cooking and can be made up into palatable and appetizing foods. Some, like wheat and barley, are ground into flour to make *chapattis* or bread because they contain a substance called *gluten* which binds the bread together. Others, like rice, cannot be made into bread because they do not contain enough gluten, so these are boiled and then eaten as they are. Now so long as this is all we do to the grains we do not harm them much and we get out of them most of the good they contain. Fortunately, it is all we can do to some of them. So grains like ragi, cholam and cambu are good foods because they are usually eaten in their natural state.

Wheat. People are not always content to eat wheat in the form of whole wheat flour *atta*, which is made by grinding the whole wheat grains to powder and sifting off the coarser particles of bran. This is by far the best way to use wheat because we get in this way all the proteins, fats, carbohydrates, mineral salts and vitamins the grain contains. This is the way in which people living in the wheat-growing areas of Northern India prepare it as food. Because the *outer* layers of the wheat grain ('c') contain some proteins of the

'suitable' kind, because wheat is rich in manganese which is good for growth, and because the wheat-eating races of Northern India are accustomed to use milk, milk-products, green vegetables and fruit with the atta, these races are amongst the tallest, the strongest and the most vigorous in India. Those amongst them who do not take enough milk, milk-products and green vegetables are, however, liable to suffer from certain illnesses because the *atta* by itself does not contain enough suitable proteins nor enough vitamin A nor enough of certain mineral salts. It is only people who grow their own wheat, or who can buy wheat to grind into *atta* as they want it, who can use the wheat in this way. Whole wheat flour (*atta*) should always be freshly made; when kept it soon goes bad and is not, therefore, suitable for sale in the bazaar. So wheat is now-a-days usually made into white flour or *maida*, which keeps better; *maida* is manufactured in India itself or it is imported into India for sale in this form.

White flour consists only of the central part of the grain ('b') (see figure). In its manufacture the other parts ('a' and 'c') are removed and thrown away; and as these parts contain the best of the proteins and most of the mineral salts and vitamins little is left but the carbohydrates and the poor or 'unsuitable proteins' contained in the central part of the grain. One important mineral largely lost in the manufacture of white flour is manganese, which is a stimulant of growth. White flour is thus very inferior to whole wheat flour (*atta*) as the staple article of diet. It is inferior also to whole rice, ragi, cholam, cambu or barley, and it should

not be used instead of these grains. But now-a-days white flour is being more and more used in India by people who live in towns because it is convenient to buy it in the form of loaves which save the trouble of cooking or of pounding rice, or of grinding wheat into *atta*, or of making ragi-flour. But we have always to pay dearly for things that are convenient and save trouble, and we must pay dearly in health for using white bread as our staple food unless we are rich enough to buy other foods containing the very things—proteins, mineral salts and vitamins—which we throw away when wheat is made into white flour. Yeast is used to make white flour into loaves of bread, and yeast is rich in vitamin B. Some people think that they get enough of this vitamin from the yeast in the white bread. This is a mistake; the amount of yeast used to make the bread is small, and the amount of vitamin B to be got from a loaf of white bread is not nearly so great as that to be got from the same amount of whole wheat flour. Unless we can afford to take *plenty* of the 'protective foods'—milk, fruit and green leafy vegetables—with white bread it is best not to use white flour at all but to use *atta*, whole rice, ragi, cholam or cambu instead.

Wheat is a 'heating food'; it is more suitable for cold climates, or for climates that are cold during part of the year, than for climates that are very hot all the year round. It is very suitable, therefore, for people who live in the North of India and for them it is a very strengthening food; but it is less suitable, as the *only* cereal food, for those who live in the Southern and hotter parts of India. For these it is a very good thing

to take *some atta* with their rice each day or to have *atta* chapattis at one meal and rice at another, because the *atta* provides the vitamin B which is so often wanting in white rice. In this way they will be protected against the disease called beri-beri.

The best of all the diets used by Indian races is one composed of whole wheat flour (*atta*) or of home-pounded rice and *atta* in equal parts, milk, milk-products, dhal, fruit and green leafy vegetables with flesh meat two or three times a month. No diet eaten by man is capable of producing greater physical perfection, strength and vigour than this.

Ragi or **Bajri** (millet): Next to whole wheat, ragi or bajri is one of the most nutritious of the cereal grains. Its proteins are not quite so good as those of whole wheat but it has this advantage over wheat that it contains more vitamin A. It is rich in vitamin B and since the whole grain is always used after grinding into meal, or as porridge, ragi-eaters rarely suffer from vitamin-B-deficiency. But sometimes they may suffer from this disease because the amount of vitamin B in ragi varies so much with the kind of soil on which it is grown and with the way the soil is manured. If the soil is very poor and is much exhausted by the constant growing of ragi upon it, without being properly manured with cattle manure, then the quality of the ragi crop is bad and may be harmful to people who eat it. But good ragi (or bajri), either alone or with rice, when eaten with a sufficiency of milk and milk-products or fish, *and* green leafy vegetables and fruits, is one of the best diets used by Indian races.

LESSON XVI

Rice. This is one of the commonest of the food grains used in India; indeed, it is the chief food of more than one half of the human race. About one-quarter of the whole population of India live on rice. It is grown in places where the climate is hot and damp and where the fields can be irrigated. It is the staple article of food in parts of the Madras and Bombay Presidencies and in Lower Bengal, Burma and Kashmir. In the rest of India rice is a luxury.

There are many kinds of rice all differing from one another in their nutritive values. All have the same general defects as the other cereal grains: deficiency of suitable protein, mineral salts and vitamins. But rice has other faults besides. (1) It contains less proteins than any other cereal grain, except maize and when it is their main source it has to be eaten in large quantities in order to obtain enough. The bulkness of the rice-eater's diet gives rise to two very important consequences: (*a*) it prevents the proper absorption from the intestines of the proteins and vitamins contained in the other foods eaten with it, such as dhals; and (*b*) it is apt to cause distension of the stomach and bowels, with fermentation of their contents and resultant indigestion and bowel complaints. This only occurs when the great bulk of the diet is composed of rice. When it is eaten in lesser amounts, as when one meal of the day consists of *atta*

and another of rice, it is an excellent food. When the food consists of rice and dhal not more than one part of dhal to five parts of rice should be eaten. (2) The proteins of rice are of poor quality being in this respect inferior to those of wheat or ragi. (3) Whole rice, as it comes from the paddy-fields, is the poorest of all cereal grains in vitamin B. When rice is the sole, or the main, source of this vitamin then it only provides enough of the vitamin for the needs of the body—and only just enough—if the rice used be raw, home-pounded or unpolished. It provides barely enough if the rice be parboiled and unpolished. It does not provide enough vitamin B if it be white polished rice or if it be parboiled rice that has been subjected to much washing. It is because rice *at its best* is poor in vitamin B, and because it is so commonly used after milling, polishing and washing—which removes most of the vitamin B contained in the whole rice grains—that beri-beri is so common amongst rice-eating races. (4) Rice is poorer in mineral salts (calcium, phosphorus, potassium, sodium, etc.) than any other cereal grain used in India. White polished rice is even poorer than white flour in these essential constituents of food but better in this respect than refined sago and tapioca. (5) White rice contains, as we have seen, *very little* vitamin B and none at all of the vitamins A, C and D.

For all these reasons it is a poor material on which to rely for the building up of the bodily house. It is for these reasons also that the rice-eating races of India are of slighter build, less well developed physically, less robust, and less capable of hard work than wheat-eaters or ragi-eaters.

But if the rice-eater can supplement his rice with enough milk and milk-products, dhal, green leafy vegetables and fruit then he will have a diet which is well suited to the climate in which he lives and to preserve him in good health. Those who can afford to do so should also include in their diet some *atta* every day.

Rice grown on land which is watered by natural rainfall or which is only irrigated when the rainfall is scanty, is more nutritious and contains more vitamin B than rice grown in puddled fields or in standing water.

Oats. This cereal is not much used in India except by Europeans. It is more suitable for temperate than for hot climates being in the former a very valuable article of food. It is rich in fats, containing nearly five times as much as wheat. It is, or was formerly, the staple article of diet of the Scotch, and when taken with plenty of milk there is none better. Because of its deficiency in vitamins A and D it is apt to cause rickets unless foods containing these vitamins such as milk and fish, are eaten with it. Oatmeal, herrings, milk, milk-products, tuber and root vegetables, green leafy vegetables and fruit make up a very fine diet for people living in temperate regions.

Barley has about the same nutritive value as whole wheat, but it contains less gluten and so it is not so easily made into bread.

Cholam and **Cambu.** These grains are intermediate in value between wheat which is the best and rice which is the worst of the cereals. They contain twice as much fats as wheat and nearly fifteen times as much as rice.

Maize, or Indian Corn, has certain peculiarities: its proteins are very poor and this is *one of the reasons* why maize-eaters are so prone to suffer from a disease called Pellagra. The yellow corn contains considerably more vitamin A than other cereal grains or than the white variety or cholam. For this reason it is a very useful *addition* to the food, though as the staple article of the diet it is bad unless other foods which make up for its deficiencies are freely used with it.

Linseed is commonly used as food in some of the colder parts of India. It is very rich in fats: linseed oil being extracted from it. It contains more vitamin A than wheat; about the same amount as ragi. It is rich in vitamin B but has all the other faults of the cereal grains and seeds in general. It is a strengthening and fattening food, but it ought not to be eaten in large quantities.

Now although some of the grains and seeds here mentioned contain some vitamin A, and some of them more than others, none of them contain enough of this vitamin. Indeed, most of the cereal grains when eaten whole require to be eaten with milk and milk-products or fish or egg in order to provide plenty of vitamin A, otherwise they are likely to cause stone-in-the-bladder; a disease which is very common in parts of India where whole cereal grains are eaten largely by people who cannot afford to take enough milk and other vitamin A-rich food-stuffs, with them.

In Lesson XV we learnt that all the cereal grains are deficient in 'suitable' proteins: some lack one kind of protein fragment, some another. So it is a very good

thing not to confine ourselves to the use of only one cereal grain but to use a mixture of several such as of rice, wheat and ragi, because the protein fragments that may be lacking in one grain may not be so lacking in another. In this way the kind of proteins needed by the body are more likely to be provided. Grown-up people can do with very little animal protein if they eat several kinds of cereal grains, but for growing children animal protein is a most essential part of their food.

Suji or semolina is the coarse part of the wheat grain which is sifted off after grinding. It contains a fairly high proportion of proteins some of which are of the suitable kind. It is rich in vitamin B and should be much more widely used in India as a source of this vitamin by both rice-eaters and white flour-eaters.

LESSON XVII

Dhals. These belong to the same order of plants as **peas** and **beans** and have in general the same qualities; so what is here said about dhals applies also to peas and beans, except that the dhals are more digestible. There are seven different kinds of dhal: Arhar, Massur, Gram, Mung, Mattar, Kalai and Urid. Their chief value lies in the large amount of protein they contain and it is for this reason that they are so largely used in India. They contain about twice as much protein as wheat and four times as much as polished rice. Their proteins are better than those of the cereal grains though not so good as those of milk and meat; they help, however, to make up for the defects in the proteins of the cereal grains and are a very good addition to the rice-eater's and wheat-eater's diets. One ounce of any of the dhals contains as much protein as one ounce of meat, nearly twice as much as one ounce of egg and seven times as much as one ounce of whole milk. The great difference between the cereal grains and the dhals is that whereas a man can eat a pound of *atta*, rice or ragi without doing himself anything but good, provided he takes milk and green leafy vegetables with them, he cannot eat a pound of dhal, peas or beans, as a regular part of his diet, without doing himself harm; because by so doing he would be taking far too much protein. And the great difference between the dhals and the animal foods—meat, milk eggs and fish—as

sources of protein is that the proteins of the dhals are of the 'less suitable' kind while those of the animal foods are of the 'suitable' kind. It is therefore, better to take seven ounces of milk or $1\frac{3}{4}$ ounces of egg, or one ounce of lean meat than one ounce of dhal though all contain about the same amount of protein. This does not mean that the proteins of dhal are no use nor that dhals are bad foods. All it means is that dhals, as the *only* sources of protein, are not as good as these animal foods nor so able to make up for the poorer quality of the proteins in the cereal grains which form the bulk of the food. But if we combine dhal and rice with milk or meat or eggs or fish then the 'suitable' proteins contained in these animal foods make it possible for our bodies to use to the best advantage the 'less suitable' proteins contained in the dhal and rice.

Dhals are eaten in various ways, and the way they are cooked makes a great difference to the good we get out of them. The best way to use them is to grind them into meal and to make them into chapattis with *atta* or barley or other suitable cereal grain; but rice cannot be made into chapattis, so rice-eaters usualy boil the dhal and make it into a kind of porridge, or they cook the rice and dhal together. If the water used for boiling the dhal is hard and contains much lime it makes the dhal very indigestible; when cooked in this way the water used should be soft. Sometimes the dhal or gram is fried or parched and eaten dry: when cooked in this way it must be thoroughly chewed, as in this form it is less digestible than when ground into meal.

A man cannot digest more than 4 or 5 ounces of dhal

a day; anything over this amount is simply wasted and goes bad in the bowels. People who eat dhal and rice should remember this. If a great deal of rice is eaten with the dhal it prevents the dhal being properly digested; so if a man eats twenty ounces of rice a day he ought not to eat more than four ounces of dhal, and it will be much better for him to take only two ounces of dhal with fourteen of milk or three and half of egg or two of fish or meat instead to the four ounces of dhal.

The best dhals are Arhar and Mung. Whole dhal (*sabut*) is much better than washed (*dhuli*) or split (*dali*) dhal. Boiling dhal in water reduces its content of vitamin B.

All the dhals are poor in certain mineral elements (calcium, sodium and chlorine), but are rich in iron and phosphorus. They are all rich in vitamin B and are, therefore, good for preventing beri-beri. But if the food consists of polished rice then we can only be sure of preventing beri-beri if with every five ounces of rice we take one ounce of dhal. If we take less dhal than this beri-beri may arise in places where this disease is prevalent,

The dhals contain very little vitamin A and no vitamin C; but vitamin C can easily be made from dhals, peas and beans by sprouting them in the way described in Lesson XII. The sprouts also contain vitamin A. Sprouting improves the flavour of dhals, and by generating vitamins A and C greatly improves their nutritive value.

Soya bean is a rich source of proteins which are of

fairly good quality. It is rich in fats and vitamin B. For these reasons it is a favourite food amongst the Chinese and the Japanese peoples. It is a pity that it is not more grown and used in India.

Nuts of all kinds are rich in proteins and most of them are also very rich in fats: their proteins are fairly good, being better than those of the cereal grains or dhals. In these respects they are like soya bean. They have a pleasant flavour but as they contain so much protein and fat they are very rich foods and cannot be eaten in large quantities. An ounce of nuts contains more protein than an ounce of egg and five or six times as much fat. Nuts are rich sources of vitamin B, but they contain very little vitamin A and no vitamin C. They should always be eaten with, and not at the end of a meal and should be well chewed.

Leafy Vegetables. We have learnt that these are one of the three classes of 'protective foods.' They are called protective foods because (1) they contain all the mineral elements—calcium, sodium and chlorine—in which the cereal grains are lacking and, therefore, they provide the mineral salts that are deficient in our staple food grains; (2) they keep the blood of proper re-action, and prevent it from becoming acid thus balancing the acid-producing tendencies of meat and cereal grains; (3) they contain some 'suitable' proteins which help the body to make use of the 'less suitable' ones that are present in our staple food grains; (4) they are rich sources of the vitamins A, B and C; and, (5) their framework—which is composed of cellulose—helps the action of the bowels. The last is a very important

point, for if all the ingredients of our food—proteins, fats, carbohydrates, mineral salts and vitamins—were provided in a highly purified form then there would be little residue on which the bowels could act and so constipation would occur. But the clean, smooth, non-irritating vegetable matter, left after the intestines have dissolved out of the leaves all the nutritive materials they contain, serves the further purpose of helping the bowels to act properly.

Fruits and berries serve some of the same purposes as green leafy vegetables. They are amongst the best of all food-stuffs and should form a considerable part of our daily diet. They contain much mineral salts of the alkaline kind which keep the blood pure and prevent it becoming acid or sour. Fruits are most useful in keeping the bowels healthy and active. *The tomato* is one of the best of all vegetables and should be much more largely grown and used as food by people of all classes in India. It is rich in the three vitamins A, B and C and when eaten in sufficient amount is a sure protection against beri-beri and scurvy. *Bananas* are difficult to digest unless they are fully ripe, with the skin just beginning to blacken. They contain very little vitamins but are useful foods because they contain starch and sugar. A very good way to eat fruit is as a meal by itself. It should always be well chewed because the saliva in the mouth contains a substance which is necessary to its proper digestion.

LESSON XVIII

Tuber and **Root Vegetables.** These include all vegetables such as potato, tapioca, sweet potato, yams, artichokes, parsnips, turnips, beetroot, carrot, onion and the many roots used as food by different races in India. Some of these, such as potato and tapioca are rich in carbohydrate—starches or sugars—and are, therefore, good sources of 'fuel food'; others, such as onions and carrots contain less carbohydrate. All have proteins of the 'less suitable' or the 'unsuitable' kinds. They are all good sources of mineral elements. They contain less vitamin B than the cereal grains, and very little vitamin A except those that are of a yellow colour such as carrots and sweet potatoes. It is a good rule to remember that all yellow and yellowish-red vegetables, whether roots or other parts of the plant, contain more vitamin A than white vegetables or white parts of vegetables. Thus the white inside of a cabbage contains less vitamin A than the green leaves surrounding it. All root vegetables contain some vitamin C which is, of course, largely destroyed when the vegetables are boiled. Tapioca is the staple article of diet in some parts of India. It contains very little protein and when purified it is very poor in vitamin B. It also contains very little fat. Sago has more protein and fat than tapioca but no more vi[illegible]

Onions and garlic are amongst the most valuable of all vegetables. In addition to their value as food they contain a powerful antiseptic agent.

Vegetable oils are good as fuel foods but, as we have learnt in Lesson VII, they are very inferior to animal fats because they contain so little vitamin A; and when they are hardened and made into 'vegetable ghees' they contain none at all. One of the greatest of the food difficulties in India is to secure a sufficient amount of vitamin A; if from other sources we can get enough of this vitamin, then the vegetable oils, either fresh or in their hardened form are very useful articles of diet.

Coffee and **tea** are much used in India by people of all classes. They are not foods but stimulants; their stimulating action being due to the presence in them of a substance called *caffeine*. Used *in moderation* they do little harm and are a solace to many who have few other comforts in life, but their excessive use is harmful.

Condiments such as chillies, tamarind, saffron, coriander, zeera, mustard, pepper, cloves, cinnamon, garlic, cardamoms, asafoetida, ginger, nutmeg, cassia and mace are used chiefly for their flavouring and appetizing qualities; they add but little to the nutritive value of the food as a whole. Seeds, used as condiments, have the properties of seeds in general being rich in vitamin B and containing little or no vitamins A, C and D; chillies contain some, though not much, vitamin A.

Having now learnt the properties of the different classes of food-stuffs we are in a position to say what

the defects of any Indian diet are, and how these defects may be rectified. Everything the Indian child eats falls into one or other of the following groups of food-stuffs :

(1) Milk and milk-products.
(2) The flesh of animals.
(3) Animal fats.
(4) Vegetable oils.
(5) Cereal grains.
(6) Tuber and root vegetables of all kinds.
(7) Dhals, peas and beans.
(8) Nuts and seeds of all edible kinds.
(9) Leafy vegetables of all edible kinds.
(10) Fruits and berries of all edible kinds.

In a country like India where so many different kinds of vegetable foods are used it has not, so far, been possible to complete the analysis of every one of them nor to find out just how much or how little of each particular vitamin, or of each particular salt, every one of these vegetable foods contains. But this detailed knowledge is not necessary for a proper understanding of the **choice of food.** Because if we want to know the food-value, let us say, of some particular root-vegetable which is not mentioned in these Lessons by name, nor in the Table of Food-values at the end of the book, then it may be assumed to have about the same value and properties as those of other roots that are mentioned. Of it some kind of vegetable oil has not been mentioned then it may be assumed to have about the same value

and properties as other vegetable oils that have been mentioned (see Table at end of book).

As an exercise in applying the knowledge gained in previous Lessons we shall in the next Lesson consider the faults of some of the national diets of India and how to correct them.

LESSON XIX

The faults of Indian diets and how to rectify them. In previous Lessons we have learnt the nature of the defects of the different food grains—wheat, rice, barley, maize, cholam, cambu and ragi—which form the staple articles of diet of the different races of India. And we have also learnt what are the qualities of the other food-stuffs which make them able or unable to make good the defects of the cereal grains.

Supposing the staple article of diet is **wheat** and that this is eaten in the form of *atta*. The *atta* provides enough carbohydrate but not enough fat. The latter must, therefore, be added. The best way to do this is by taking butter, ghee, or mutton fat (*charbi*) with the *atta* because these animal fats not only provide the fat required as fuel food but vitamin A as well. Vegetable oils will provide the fat but not enough vitamin A.

The proteins of *atta* though better than those of most other grains are not good enough nor are there enough of them. So we must select some other food to eat with *atta* which will provide a sufficiency of 'suitable' protein (Lesson IV). For this purpose we can take milk, either as fresh milk or sour milk or curds or buttermilk or cheese; or we can take meat or poultry, or liver or fish or eggs. If a man eats one pound of *atta chapattis* a day, he will get all the suitable proteins he needs by taking with them plenty of green leafy vegetables and a pint and a half of milk, though he will be a stronger man if he takes a quart; or by taking green

leafy vegetables and a pint of curds, or green leafy vegetables and 4 or 5 ounces of meat, or 2 or 3 eggs. It is both economical and advantageous that a certain amount of the proteins added to *atta* should be provided from vegetable sources such as dhals.

A third defect of *atta* is its deficiency in vitamin A: so some other food-stuff must be selected which makes good this defect (Lesson X). The best food to do this is whole milk or its products—butter and ghee; so that by taking milk and butter or ghee with the *atta* we not only provide the 'suitable' proteins and fats but the vitamin A in which it is deficient: we thus make good three of the chief defects of the wheat. We can get the vitamin A from other sources besides milk, butter and ghee: such as from fish, eggs, liver, kidney and green leafy vegetables. By taking green leafy vegetables and meat, or egg, or liver, or kidney, or fish, with the *atta* we make good two of its chief defects: suitable proteins and vitamin A. Some of these animal foods—egg, liver and fat-meat—will also make good the deficiency of fats in the *atta*.

A fourth defect of *atta* is its deficiency in vitamin C. So we must select some food or foods which are rich enough in this vitamin to make good this defect. The best foods for this purpose are green leafy vegetables or sprouted gram (Lesson XII). Thus by taking milk, milk-products and green leafy vegetables we make good four of the defects of the wheat: fats, suitable proteins, vitamin A and vitamin C.

A fifth defect of *atta* is its deficiency in vitamin D: a food-stuff has, therefore, to be selected to rectify this;

and we can choose either milk and its products—butter or ghee—or egg or fish oil for this purpose (Lesson XIII). Any one of these, or the action of sunlight on the body with an occasional oil bath will provide all the vitamin D we need.

A sixth defect of *atta* is its deficiency in certain minéral elements, particularly calcium, sodium and chlorine. So we must select foods to eat with the *atta* which will provide these minerals. The best foods for this purpose are green leafy vegetables, fruit and milk (Lesson V); and as wheat does not contain much iron some of the vegetables used should be rich in this element (Lesson VII). It is well to combine *atta* with plenty of vegetables and fruit so that the non-irritating vegetable matter may help the action of the bowels, and the acid-producing tendency of the *atta* may be counteracted by the alkali-producing tendency of the vegetables and fruit.

We see, therefore, that if whole wheat flour (*atta*) be the staple article of diet and we take with it milk, milk-products, dhal, green leafy vegetables and fruit with flesh meat occasionally we get everything the body needs for health, strength and vigour. Now this is precisely the kind of food which the wheat-eating races of the North of India do eat, if they can get it; and for this reason no races of Mankind are better developed physically nor more capable of endurance and hard work. But it is only when they actually do eat this kind of food and make good each and every one of the defects of the wheat that they remain in good health and vigour even unto old age.

Now supposing the staple article of diet is **rice.** The rice may either be *raw, home-pounded rice,* or *polished, home-pounded rice,* or *raw, milled and polished rice* or *parboiled, milled and polished rice.* Whatever rice is used it contains enough carbohydrates, or 'fuel food,' but its proteins are not only scanty in amount but are poor in quality. So this defect must be put right in the same way that it has to be put right for wheat; with these differences, however, that there is twice as much protein in wheat as there is in polished rice and that the proteins of wheat are better than those of rice. So we must make up the *quantity* of proteins as well as the *quality.* This we can do by taking three or four ounces of dhal, in addition to the green leafy vegetables *and* milk or curds or meat or eggs which we have learnt it is necessary to take with wheat.

Rice does not contain enough fats and, therefore, the rice diet must contain butter, ghee, or vegetable oils: the first two being much the best, because they contain vitamin A in which rice is very deficient.

The great fault of rice is that it contains so little vitamin B, this deficiency being greater when rice is milled and polished or when it is parboiled and much washed. So we must select some food or foods which will provide the vitamin B in which rice is lacking. By far the best way to do this is to substitute *atta* (whole wheat flour) for one-quarter to one-half of the rice ordinarily eaten. The *atta* contains much vitamin B, and besides this it increases the quantity and quality of the proteins in the food. But many people in the South and East of India cannot get *atta,* so the next best

thing to do is to take dhal with the rice: one part of dhal to every five parts of the rice, and not more than four or five ounces of dhal a day. The addition of this amount of dhal to the rice diet increases both the vitamin B content of the food and the quantity of protein. So that by adding *atta* or dhal and green leafy vegetables *and milk* to the rice diet we make good the defects of the rice so far as the quantity and quality of proteins and so far as the quantity of vitamin B is concerned.

The other defects of the rice are the same as those of wheat and must be put right in the same way.

Now supposing the staple article of diet is **millet** (ragi or bajri). The defects of this grain are these: (1) It contains more protein than rice, but less than wheat, and its proteins while better than those of rice are not quite so good as those of wheat; (2) it contains two to three times as much fat as rice, but not quite enough to make further addition of fat to the food unnecessary; (3) as it is eaten after grinding into meal it contains plenty of vitamin B, but too little vitamin A and no vitamin C or D; (4) it is, like all other cereal grains, poor in certain mineral salts though more deficient in calcium than wheat or whole rice; and, (5) it lacks the necessary vegetable residue to help the action of the bowels. So in order to make the ragi-eater's diet complete foods containing suitable protein must be added to it, while its deficiency in fats, vitamins and mineral salts must be put right in the same way as we have learnt to put right the deficiencies of wheat and rice.

Similarly with the other staple food grains—barley, maize, cholam and cambu—the defects of these are the defects of cereal grains in general and they can be corrected in the same way as those of wheat, rice or ragi. As was said in Lesson XV the physical efficiency, vigour, capacity for hard work and health of the different races of India depend on the way in which the defects of their staple food-grains are corrected. The great difficulty in India is for people to get the food-stuffs which are so necessary for the correction of the defects of the cereal grains. But if the rising generation learns what these Lessons are intended to teach they may, when they grow up, set about the cultivation of the land in such a way that it, and the cattle, sheep, goats and fowls raised upon it, will provide them with the food-stuffs necessary for their health and well-being.

The faults of Anglo-Indian and European diets in India are of the same general kind as those of Indian diets and can be rectified in the same general way. But whereas Indian diets are often very deficient in 'suitable proteins,' Anglo-Indian and European diets rarely are, because they contain much more animal food. Now any diet which is composed of white bread, butter, meat, boiled potatoes, a little boiled vegetables, jam, rice, sago, tapioca, tea or coffee with sugar and a little milk will not contain enough mineral elements such as calcium nor enough vitamin A, B and C for the most vigorous health. The means of correcting these defects are: (1) the liberal use of the more easily digestible green leafy vegetables, such as lettuce and spinach and raw tomatoes; (2) the liberal

use of fresh, raw fruit, oranges, papoya, etc; (3) the substitution of whole wheat bread or *atta chapattis* for white bread and for cakes made of white flour; (4) the more generous use of milk. Experience of European and Anglo-Indian children in India shows that the great majority of them are suffering from chronic deficiency of vitamins A and B which is made all the greater by the relatively large amount of meat and other protein-rich foods they eat and by the large amount of starches, sugar, sweets and jams which is given to them. Very often, too, the amount of milk they take is far too small. It would be infinitely better for them if they took less meat and more milk (either boiled, or sour, or butter-milk, or even skimmed milk), less white bread, less cakes and sugar, more whole wheat bread or *atta chapattis*, more suji and more green leafy vegetables and fruit. If these simple things form the basis of their dietaries from early childhood they will not develop the craving for sweets, cakes, etc., which so many show, and is often in itself a sign of wrong-feeding. For such children the following rules should also be remembered: (1) Nothing out of a tin is as good as the fresh food; (2) no highly purified food is as good as the same food as provided by Nature; (3) no preserved food is as good as the fresh food; (4) it is wholly unnecessary to eat any tinned, highly purified or preserved foods if the fresh food can be got; (5) be sparing in the use of salt, sugar or sweets; (6) clean all green leafy vegetables carefully in boiled water before they are eaten raw, and be sure that the source from which they come is clean; chew th[illegible] eating them; (7) boil all milk

before use; (8) use buttermilk or 'sour milk' when procurable; (9) drink plenty of pure water; (10) eat only at regular hours; and, (11) chew the food thoroughly before swallowing it.

Most cows' milk in India is of poor quality and likely to have a very low content of vitamin A. It is well, therefore, to give children an eggspoonful or a small teaspoonful of cod-liver oil *once a day* to make sure that their food is not lacking in this important vitamin. In this amount it is a food and not a medicine; it must not be given in larger amount. The difference which it makes to the health of European children in India is remarkable.

Many vitamin-containing preparations are now-a-days made by manufacturing chemists and others and sold at an expensive rate. The use of such preparations is wholly unnecessary, provided the food be chosen aright. The best way to get vitamins is as Nature provides them in suitable combination with all the other elements and complexes necessary for normal nutrition.

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LESSON XX

The Teeth. These structures are amongst the most important in the body; on their proper development and care good digestion and good health largely depend. The 'centres' or buds from which the first set of teeth grow are laid down in the jaws, and the teeth themselves have begun to form beneath the gums, before the baby is born. So it is that anything which disturbs the health of the mother before the birth of her child will interfere with the proper development of the child's teeth. Illnesses of the mother can do this; but another important cause of bad teeth in children is the wrong food eaten by the mother before the birth of her child. We have learnt in previous Lessons that the chief 'building materials' used in making the teeth are calcium, phosphorus and fluorine. The vitamins or 'builders' needed to build these materials into sound teeth are those which occur in animal fats—vitamins A and D; the latter being the more important of the two. Besides these, two other vitamins, B and C, help in the building process. For the proper development of her baby's teeth it is necessary, therefore, that the mother's food should be of the right kind: that is to say, it should contain plenty of mineral elements—lime, phosphorus, etc.—and plenty of vitamins. This it will do if with any whole cereal grain, she also takes milk, milk-products and plenty of green leafy vegetables and fruit. If, however, she lives in Purdah and does not enjoy plenty of sunshine she must also take cod-liver oil or other fish oil in order to make up for any lack of sunlight. Unless she eats this kind of food the jaws of

the baby are likely to be small and badly formed and the teeth, when they appear, are likely to be crowded together and to decay early. The mother must also be careful not to eat more than she can comfortably digest, and to take a reasonable amount of exercise.

The teeth are intended by Nature to tear and chew the food; this chewing keeps them in good exercise and healthy and strong, provided the food be of the right kind and the teeth be properly looked after. So sloppy foods and foods, like curry and rice, which do not require much chewing nor exercising of the teeth, are likely to cause dental decay. Such foods are composed mainly of starches which may collect around the teeth or between them and the gums. There the starch ferments and produces acids which may erode the teeth. After starchy foods have been eaten the teeth and gums should always be washed with cold water using the first finger as a tooth-brush; or an even better plan is to end up a meal of starchy food with some raw fruit or vegetable into which the teeth have to be sunk. The biting and chewing of the raw fruit clears away any starch which may be clinging about the teeth, and the fruit or vegetable juices prevent the fermentation of the starch and the formation of harmful acids.

The next rule in the care of the teeth is to keep the mouth very clean. It should be washed out with cold water first thing in the morning and last thing at night as well as after every meal. There is no better way to cleanse the teeth than by the use of a chewed stick of acacia; this is a common practice in India. If acacia

is not available the first finger may be used instead; either is as good if not better than the modern tooth-brush.

The saliva (or spittle) in the mouth is one of the chief means of keeping the mouth and teeth healthy; just as the tears are one of the chief means of keeping the eye healthy, and the secretions of the lining mucous membranes of the nose, the wind-pipe and the intestines, are one of the chief means of keeping these organs healthy. All these secretions help to counteract the growth and harmful effects of microbes. But when the food is of the wrong kind and does not contain enough vitamins these secretions become scanty and lose their powers of killing microbes; then microbes grow which may set up dental decay. Pockets of 'pus' may also collect around the teeth and cause a condition called *pyorrhoea*. Now this condition is extremely common in India and food deficient in vitamins together with failure to keep the mouth and teeth clean are amongst its causes. When pus forms in this way about the teeth it is always being swallowed, and as it is full of microbes, which may be capable of causing disease, the effect on the health is very bad: indigestion, loss of strength, poor blood, nervousness, depression and pains in the joints may be caused in this way. You may be certain when a person's mouth and teeth are in this condition that his inside is not as healthy as it ought to be and for the very same reasons: faulty food deficient in vitamins and the infection by microbes which results from it. So this Lesson about teeth is one that applies to other parts of the body as well.

LESSON XXI

The gastro-intestinal tract. This tract is made up of the mouth, the gullet, the stomach, the small intestine, the large intestine and the rectum. In a full-grown man it is about 30 feet long. It is lined throughout its whole extent by a velvety lining called 'mucous membrane'. When we take food into the mouth it is first thoroughly chewed and mixed with the saliva (or spittle) produced by glands near the mouth. This saliva, in addition to being a kind of antiseptic, contains a substance which starts off the process of digestion. So when we bolt our food, and do not chew it properly, we give the digestion a bad start. The food thus mixed with saliva passes through the gullet into the stomach where it becomes mixed with another digestive juice and with hydrochloric acid, both of which are produced by the mucous membrane of the stomach. The hydrochloric acid kills any microbes not killed by the saliva. The food stays in the stomach long enough for it to be thoroughly mixed up with these digestive and antiseptic juices; and to ensure its thorough mixing the walls of the stomach contain muscles which, by contracting and relaxing this way and that, churn up the food and mix it with the digestive juices. The muscular action of the stomach is a very important part of the digestive process. After the food has been thoroughly mixed up in this way, with the digestive juices of the stomach, it is passed out by

muscular contraction into the next portion of the digestive tube: the small intestine. There it meets other juices which carry the digestive process still further and ultimately reduce the food to a liquid state. From this liquid food, the cells covering the mucous membrane of the small intestine then proceed to select the materials needed by the body. Some pick out fats and some proteins, some mineral salts and some carbohydrates and some vitamins; everything in fact which the body needs including water. At the same time the muscular walls of the small intestine, by their contraction, propel the food along its course through the tube; and by the time it has reached the end of the small intestine everything the body needs has been taken out of it, provided the food eaten contained everything. The residue then goes into the large intestine where it is squeezed by the powerful muscular walls and more water is taken out of it and absorbed into the body by the lining membrane of the large intestine. Finally, what is not wanted is passed into the rectum, and so out of the body once or twice a day.

Now you will realize that this digestive tube, called the gastro-intestinal tract, has got a lot to do: (1) it has to do its best to kill any disease-producing microbes that are swallowed with the food; (2) it has to produce the digestive juices which will digest the food and turn it into a liquid mass; (3) it has to mix the food with the digestive juices by the action of its muscular walls; (4) it has to absorb all the things the body wants from the liquid mass of food; (5) it has to extract the water from it or a great part of the water; and (6) it has, by

the action of its muscular walls, to pass the food from one part of the tube to the next, and the residue out of the body. *Every one of these things depends on the food being of the right kind.*

If, for instance, there is not enough vitamin B in the food, the appetite becomes poor, the muscles of the digestive tube become weak and the stomach, instead of contracting as it should, becomes flabby and distended by the food which remains in it for too long a time. When this happens we become aware that we have a stomach, because it begins to be uncomfortable or even painful on account of this distension. This muscular weakness of the digestive tube prevents the various events in the digestive process happening just at the right time; so instead of its running like clockwork it goes slow, and pain, discomfort and bowel ailments are the result. Finally, the waste products of digestion are not passed out of the body as regularly as they should be and constipation arises, with headache, slackness, uncomfortable feelings and bad breath. If this constipation goes on for years it poisons the body and produces constant ill-health.

We may look at the digestive processes in another way: supposing there are not enough suitable proteins, mineral salts or vitamins in the food then the digestive juices are not properly produced and the food is not properly digested. The cells lining the small intestine fail in their duty of selecting from the food the things the body needs because they themselves are not being properly nourished and repaired. Besides all this another thing may happen: the antitoxic, or microbe-

killing, powers of the digestive tube fail and microbes swallowed with the food are not killed as they should be; so they grow on the surface of the weakly mucous membrane and they, or the poisons they produce, finally get through it like rain gets through a badly made or worn out roof. In this way microbes, causing all sorts of diseases, grow in the intestinal tube, and from it they may get into different parts of the body. These parts of the body are not able to resist them because they also have suffered from faulty nourishment and are ready to become ill. So we see that the appetite, the proper digestion of the food, the proper emptying of the bowels, the freedom of the gastro-intestinal tract from disease and the health of the body generally, all depend to a great extent on the food being of the right kind.

The right kind of food for Indian children and, indeed, for children in any country is one made up of the following simple things: (1) any whole cereal grain or mixture of cereal grains; (2) plenty of milk and the products of milk—curds, butter-milk, butter, ghee; (3) sprouted pulses; (4) eggs or liver, or meat, or fish, occasionally, if religion permits their use; (5) tuber and root vegetables; (6) abundance of green leafy vegetables; and, (7) fruit. These are the things with which the appetite should be satisfied; the things that should be eaten for health's sake. What else is eaten does not greatly matter so long as it is simple, clean, easily digestible and well prepared, and so long as the proper balance of the food in proteins, fats, carbohydrates, mineral salts and vitamins is maintained.

LESSON XXII

The amount of food needed depends on age, sex, the place in which we live and the work we have to do. When we are young and growing fast we need more food in proportion to our size than when we are full grown. As much, or slightly more, food is needed by boys and girls about the age of 12 to 16 years as by men and women. A child of 6 needs half as much food as a grown-up person, and a child between the age of 6 and 12 three-quarters as much. After middle age less food is needed. Men need more food than women and boys more than girls. More is needed in cold than in hot climates; more in winter than in summer; and more in the North than in the South of India. Those who lead an active life in work and play need more food than those of less vigorous habits. In schools, where the scale of rationing is fixed by age, an amount of food which may suffice for a child of inactive habits may not suffice for one whose habits are active. So in preparing diets for children the habits of each child must be taken into account.

The greater part of our food is needed as fuel: that is to say, for the production of the heat necessary for the body's warmth and of the energy necessary for its working. Even in children who are growing fast, and who require more food for their size than grown-up people, most of the food they eat is used for fuel purposes. When we are asleep and completely at rest energy is being expended in keeping the

temperature of the body at a normal level, in breathing, in the beating of the heart, in digestion, and in other bodily activities of which we are not conscious. More than one-half of our daily food is used up in the production of the energy required for these activities. When we wake up, even when sitting up in bed, more energy is expended and more food is needed to provide it; more still when we begin to move about and to use our muscles in play or work. So the amount of food needed for energy-production varies with the work the body has to do and even with its posture.

The various food-stuffs we eat all differ in their power to produce energy: their 'energy-value', as it is called, varies. Now this energy-value can be measured; just as we measure a thing and record its length in inches, or weigh a thing and record its weight in ounces, so we can measure the energy-value of any food-stuff and record it in what are called 'calories'. A 'calorie' is the amount of heat required to raise the temperature of one kilogramme (2·2 pounds) of water one degree centigrade: an amount of energy equal to that required for raising a weight much greater than our own bodies several feet off the ground.

The substances in food which produce energy are, as we have learnt, the fats, the carbohydrates and the spare proteins that are not needed for the growth and repair of the body tissues. One gramme (15·4 grains) of pure fat has an energy-value of about 9 calories, one gramme of pure carbohydrate an energy-value of about 4 calories, and one gramme of pure protein an energy-value of about 4 calories. The energy-value

of fats is thus a little more than twice as much as that of carbohydrates or of proteins. Now nearly every food-stuff we eat contains these three energy-producing substances, although in different amounts and proportions. By analysing food-stuffs chemists can tell us how much of fats, of carbohydrates and of proteins each food-stuff contains. So when we know how many grammes of proteins or of carbohydrates a food-stuff contains all we have got to do is to multiply the number of these grammes by 4 when we have the number of calories produced by those two parts of the food-stuff. Similarly, when we know the number of grammes of fats it contains we multiply this number by 9 which gives the calories produced by the fats. The sum total of the calories produced by the protein, the carbohydrates and the fats in any given food-stuff is its energy-value in calories. Thus one ounce of the best unpolished rice contains 2·3 grammes of proteins, 22·3 grammes of carbohydrates and 0·085 gramme of fats. The proteins give rise, therefore, to $2 \cdot 3 \times 4$ or 9·2 calories, the carbohydrates to $22 \cdot 3 \times 4$ or 89·2 calories and the fats to $0 \cdot 085 \times 9$ or 0·765 calories : the energy-value of one ounce of rice is, therefore, just over 99 calories. Similarly, the energy-value of one ounce of milk is 18 calories, and that of one ounce of mutton 42 calories.

An Indian man in the prime of life requires each day from 2,500 to 3,500 calories according to the part of India in which he lives and to the work he has to do; an Indian woman requires four-fifths of this amount, or from 2,100 to 2,900 calories. Now it is not right that

these calories should be provided from proteins only or from fats only or from carbohydrates only. The needs of the body require that they shall be provided from all three, and in the following proportions; viz., for a man: 90 to 100 grammes (3 to 3½ ounces) of proteins, 80 to 90 grammes of fats, and 360 to 450 grammes (12 to 16 ounces) of carbohydrates. This insures that the food will be well-balanced and its purposes, besides that of energy-production, properly fulfilled. In order to get 90 grammes (a little over 3 ounces) of proteins from the food-stuffs we eat we have to take much more than 3 ounces. Thus to get 90 grammes of proteins from Indian mutton alone we should have to eat nearly a pound of it, or from milk we should have to drink 4¾ pints, or from *atta* we should have to eat 1½ pounds, or from ragi or cholam 2 pounds, or from polished rice nearly 3½ pounds; while to get the same amount of proteins from cheese we should have to eat 12 ounces of it (see Table of food-values at end of book). Besides this we do not get all the proteins or fats or carbohydrates that are needed from a single food-stuff.

In choosing the food-stuffs so as to provide the necessary number of calories we must select them in such a way that the whole of them when added together will give each day for a man 90 to 100 grammes of proteins, 80 to 90 grammes of fats and 360 to 450 grammes of carbohydrates. In this way we shall get from the proteins 360 to 400 calories, from the fats 720 to 810 calories, and from the carbohydrates 1,440 to 1,800 calories; or a total of 2,520 to 3,010 calories.

In the Table following this Lesson the analyses of the

commoner food-stuffs used by Indians and Europeans in India are given, with their calorie and vitamin-values. From this Table the energy-value of any diet can easily be calculated and well-balanced diets can be devised for different races and castes. In making such calculations the following rules have to be remembered : (1) Always allow 10 per cent for waste. (2) Allow for differences in activity of different individuals, giving those who are more active or who work hardest 10 to 15 per cent more than others. (3) Not less than one-third of the proteins should be derived from animal sources. (4) Make up the vegetable proteins from more than one source, as from a mixture of dhal, *atta* and rice rather than from dhal or *atta* or rice alone. (5) About one-half of the fats should be derived from animal sources (to provide enough vitamin A). (6) Always aim at having the amount of vegetables and fruit in the diet at least four times as great by weight as the amount of meat and dhal. (7) When it is necessary to increase the energy-value of the diet so as to provide for unusual activity or work do so by increasing the amount of starches and sugars. (8) If fats are not well digested the amount may be reduced to 50 grammes and the difference made up by increasing the carbohydrates, provided the vitamin A in the diet is not thereby reduced.

We need not concern ourselves about the amount of mineral salts in the diet if we remember what we have learnt in Lessons V and VI ; for by the proper choice of food-stuffs the mineral salts will always be sufficient and in proper proportion one to another and to the other ingredients of the diet.

As to the amount of vitamins needed it is not possible to give a measure of it in figures, but this rule may be remembered: that unless the food is made up mainly of natural food-stuffs which contain an abundance of all the vitamins then we are not taking enough of them for the most vigorous health and well-being.

A well-balanced diet for a man is one in which the amount of proteins is 90 to 100 grammes, the amount of fats 80 to 90 grammes, and the amount of carbohydrates 360 to 450 grammes; in which also the proteins and fats are derived from both the animal and vegetable sources, the mineral salts and vitamins are present in abundance, and in which there is enough cellulose for the proper action of the bowels. Such a diet is one like that used by certain races of Northern India, of which the following is an example:

Food-stuff	Amount in Ounces	In Grammes			Calories
		Proteins	Fats	Carbohydrates	
Atta ...	12	46·80	6·48	244·2	1222
Rice: home-pounded ...	6	13·80	0·51	133·8	595
Meat (Mutton) ...	2	11·94	3·96	0·0	84
Milk ...	20	18·80	20·40	27·2	360
Vegetable oil ...	1	0·00	28·00	0·0	252
Ghee ...	1·5	0·00	34·60	0·0	312
Root vegetables ...	8	4·40	0·36	31·8	148
Cabbage ...	8	3·10	0·24	10·2	56
Mango ...	4	0·16	0·88	20·8	92
Dhal ...	1	6·50	0·99	16·2	100
	63·5	105·50	96·42	484·2	3221
Less 10 per cent for waste ...	6·3	10·5	9·64	48·4	322
Total ...	57·2	95·00	86·78	435·8	2899

Badly balanced diets. The following diets in use by (*a*) a poor Hindu family, and by (*b*) a well-to-do Hindu family in Madras are examples of badly-balanced diets :

(a) *The poor Hindu family diet*

Food-stuff	Amount in ounces	In Grammes			Calories
		Proteins	Fats	Carbohydrates	
Polished rice ...	21	37·60	2·70	547·9	2373
Dhal ...	0· 7	4·50	0·70	11·3	70
Black gram ...	0· 7	4·00	0·90	10·7	67
Vegetable Oil ...	0· 1	0·00	2·80	0·0	25
Vegetables ...	2· 0	1·10	0·10	7·7	36
Meat or fish ...	0·06	0·40	0·05	0·0	2
Cocoanut ...	0·05	0·08	0·72	0·4	10
	24·61	47·68	7·97	578·0	2583
Less 10 per cent for waste ...	2· 4	4·76	·79	57·8	258
Total ...	22· 2	42·92	7·18	520·2	2325

This diet contains too little protein, all of which is of vegetable origin, far too little fat, too much carbohydrate and not enough calories. It is dangerously low in all the vitamins, especially A and B and it is deficient in salts notably of calcium, phosphorus and iron. The family living on this diet were of low vitality, incapable of sustained hard work and prone to bowel complaints.

(b) *The well-to-do-Hindu family diet*

Food-stuff		Amount in ounces	In Grammes: Proteins	In Grammes: Fats	In Grammes: Carbohydrates	Calories
Polished rice	...	23	41·2	3·0	600	2599
Dhal	...	1·2	7·8	1·2	19·4	120
Gram	...	1·9	10·8	2·5	29·0	182
Vegetable Oils	...	1·2	0·0	33·6	0·0	302
Ghee	...	0·4	0·0	9·2	0·0	83
Curds	...	9·0	12·6	9·0	7·2	162
Vegetables	...	6·0	2·0	0·5	8·6	48
Cocoanut	...	2·0	3·2	28·6	15·8	334
Sugar	...	1·0	0·0	0·0	25·0	100
Milk	...	7·0	6·5	7·1	9·5	126
		52·7	84·1	94·7	714·5	4056
Less 10 per cent for waste	...	5·2	8·4	9·4	71·4	405
Total	...	47·5	75·7	85·3	643·1	3651

This diet is too poor in animal protein and animal fat too rich in carbohydrate, and too high in calories. It should be adjusted by reducing the amount of rice eaten, by substituting unpolished for polished rice and by increasing the amount of milk, milk-products, green leafy vegetables and fruit.

Proteins, fats and carbohydrates in grammes per ounce, calorie-value and vitamin-content of common food materials used in India

Food-stuffs	Proteins in Grms	Fats in Grms	Carbo-hydrates in Grms	Calories per ounce	Vitamins			
					A	B	C	D
Milk and Milk-Products								
Cows' Milk ...	0·94	1·02	1·36	18	+ + +	+ +	+	+
Human Milk ...	0·42	1·50	0·75	18	+ to + +	+	+	...
Cream ...	0·70	5·24	1·27	55	+ + +	+	...	+
Cheese ...	7·35	8·88	0·50	111	+ +	V.L.	...	...
Butter Milk ...	0·85	0·14	1·36	10	+	+	+	...
Skimmed Milk ...	0·96	0·08	1·44	10	+	+	+	...
Dadhi ...	1·40	1·00	0·80	18	+ +	+	+	...
Sheep's Milk ...	1·50	2·00	1·41	30	+ + +	+	+	+
Goat's Milk ...	1·21	1·13	1·21	20	+ + +	+	+	+
Buffalo's Milk ...	1·35	2·18	1·24	30	+ + +	+	+	+
Flesh Meat and Eggs								
Lean Beef ...	6·20	2·06	...	43	V.L.	+	V.L.	+
Lean Mutton ...	5·97	1·98	...	42	V.L	+	V.L.	+
Goat's Meat ...	7·20	0·75	...	36	0	+	V.L.	0

Pork	...	6·05	3·14	...	53	0	+	0	...
Bacon	...	5·00	15·00	...	155	0	...	...	...
Liver	...	6·11	1·70	0·76	43	+ + +	+ + +	+	+
Kidney	...	4·54	1·36	0·06	31	+ +	+ +	...	...
Brain	...	2·90	2·77	...	37	+	+ +	...	...
Tongue	...	4·41	5·43	...	67	0	+	...	...
Fat Fish	...	5·32	3·70	...	55	+ + +	+	...	...
Non-fat Fish	...	5·15	0·20	...	22	...	+	...	...
Freshwater Fish	...	5·50	1·15	...	32	...	+	...	...
Chicken	...	6·74	0·38	...	30	+	+	...	...
Duck	...	5·80	2·94	...	50	+	+	...	...
Pigeon	...	6·25	1·86	...	42	+	+	...	...
Eggs	...	3·79	2·97	...	42	+ +	+ + +	...	+
Animal Fats									
Beef fat, mutton fat	...	0·34	26·40	...	239	+ +	...	...	...
Lard	...	...	26·80	...	241	0 to V.L.	...	...	...
Butter and Ghee	...	...	23·10	...	208	+ + +	...	...	+
Cod-liver Oil	...	...	28·00	...	252	+ + +	V.L.	...	+ + +
Fish-liver Oil	...	...	28·00	...	252	+ + +	V.L.	...	+ +
Vegetable Oils									
Cocoanut Oil	...	...	28·00	...	252	+	0	0	V.L.
Gingelly Oil	...	...	28·00	...	252	V.L.	0	0	0
Linseed Oil	...	...	28·00	...	252	V.L.	0	0	...
Groundnut Oil	...	...	28·00	...	252	V.L.	0	0	V.L.
Olive Oil	...	...	28·00	...	252	V.L.	0	0	...

Proteins, fats and carbohydrates in grammes per ounce, calorie-value and vitamin-content of common food materials used in India

Food-stuffs	Proteins in Grms	Fats in Grms	Carbo-hydrates in Grms	Calories per Ounce	Vitamins			
					A	B	C	D
Vegetable Oils—(Contd.)								
Cotton-seed Oil ...	...	28·00	...	252	V.L.	0	0	...
Mustard Oil ...	...	28·00	...	252	0	0	0	...
Cocogem ...	...	28·00	...	252	0	0	0	...
Margarine ...	...	23·8	...	214	0 to +	0	0	...
Sugars and Starches								
White Sugar ...	...	...	28·30	113	0	0	0	...
Brown Sugar ...	...	...	26·89	108	0	0	0	...
Goor or Jaggery ...	0·08	...	25·00	100	0	V.L.	0	...
Honey ...	0·11	...	20·21	81	V.L.	V.L.	0	...
Tapioca ...	0·05	0·01	24·83	100	0	0	0	...
Sago ...	2·18	0·04	22·00	97	0	0	0	...
Sugarcane ...	0·42	0·16	6·20	28	...	+	+	...
Cereal Grains and Bread								
Wheat (atta) ...	3·90	0·54	20·35	102	+	++	0	...
White Flour ...	3·14	0·37	21·54	102	0	V.L.	0	...

Unpolished Rice ...	2·30	0·085	22·30	99	V.L.	+	0	...
Washed Rice ...	1·62	0·15	26·34	113	0	0	0	...
Polished Rice ...	1·79	0·13	26·09	113	0	V.L.	0	...
Parboiled Rice ...	1·84	0·22	26·11	114	0	+	0	...
Ragi or Bajri ...	2·78	0·46	23·35	109	+ to ++	++	0	...
Cambu ...	3·64	1·38	19·40	105	+	++	0	...
Cholam ...	2·90	1·17	19·70	101	+	++	0	...
Barley ...	2·97	0·62	20·60	100	+	++	0	...
Oatmeal ...	3·37	2·43	19·81	115	+	++	0	...
Maize (yellow) ...	2·13	0·48	20·80	96	++	++	0	...
White Bread ...	2·00	0·33	14·80	70	0	+	0	...
Suji or Semolina ...	4·20	0·68	14·20	80	+	+++	0	...
Rice polishings ...	...	...	...	...	+	++	0	...
Dhals, Peas and Beans								
Fresh broad beans ...	2·66	0·11	6·45	37	+	++	++	...
Fresh French beans ...	0·54	0·03	1·36	8	+	++	++	...
Peas (dried) ...	1·85	0·17	4·75	28	+	++	0	...
Dhals ...	6·50	0·99	16·20	100	+	++	0	...
Grams ...	5·70	1·30	15·30	96	+	++	0	...
Soya Bean ...	9·60	4·70	9·50	119	+	++	0	...
Nuts and Seeds								
Almonds ...	5·26	15·96	4·30	182	V.L.	++	0	...
Cocoanut ...	1·61	14·31	7·90	167	+	++	0	...
Groundnut ...	7·30	10·92	6·90	155	V.L.	++	0	...
Walnut ...	3·85	19·92	3·96	211	V.L.	+++	0	...

Proteins, fats and carbohydrates in grammes per ounce, calorie-value and vitamin-content of common food materials used in India

Food-stuffs	Proteins in Grms	Fats in Grms	Carbo-hydrates in Grms	Calories per Ounce	Vitamins A	Vitamins B	Vitamins C	Vitamins D
Nuts and Seeds—(Contd.)								
Other Nuts ...	5·00	16·50	3·60	183	V.L.	+ +	0	...
Linseed ...	6·40	9·50	7·60	142	+ to + +	+ +	0	...
Tuber and Root Vegetables								
Potato ...	0·70	0·04	8·15	36	V.L.	+	+ to + +	...
Beetroot ...	0·34	0·03	1·75	9	V.L.	+	+	...
Celery ...	0·17	0·03	1·07	5	...	+ + +	+ +	...
Onions ...	0·37	0·03	3·06	14	V.L.	+ +	+	...
Garlic ...	1·92	0·03	7·90	40	+	+	+ +	...
Carrots ...	0·25	0·03	2·26	10	+ to + +	+ +	+ to + +	...
Leeks ...	0·71	0·03	2·63	14	+	+	+ +	...
Parsnips ...	0·48	0·14	5·97	27	V.L.	+	+ to + +	...
Radishes ...	0·28	0·03	0·96	5	V.L	+	+	...
Turnips ...	0·34	0·03	1·25	7	V.L.	+ +	+	...
Yams ...	0·51	0·06	6·31	28	...	+	+	...
Fleshy roots (Taro) ...	0·50	0·06	6·30	28	...	+	+	...

Proteins, fats and carbohydrates in grammes per ounce, calorie-value and vitamin-content of common food materials used in India

Food-stuffs	Proteins in Grms	Fats in Grms	Carbo-hydrates in Grms	Calories per Ounce	VITAMINS			
					A	B	C	D
Fresh Fruits and Berries— (Contd.)								
Pears ...	0·09	0·03	2·29	10	...	+	+	...
Pomegranates ...	0·18	...	0·19	2	...	+	+	...
Peaches ...	0·19	0·03	2·66	12	...	...	++	...
Pineapple ...	0·11	0·09	2·75	12	...	...	++	...
Watermelons ...	0·11	0·06	1·90	9	...	...	+	...
Papoya ...	0·16	...	0·10	1	+	+	++	...
Lichee ...	0·84	0·07	1·90	12	...	+	++	...
Mango ...	0·04	0·22	5·20	23	+	...	++	...
Guavas ...	0·37	0·20	2·27	12	...	+	+	...
Dried Fruits								
Apricots ...	1·56	0·09	14·04	63	...	...	0	...
Currants ...	0·48	0·09	11·89	50	...	0	0	...
Dates ...	0·45	0·03	19·73	81	...	+	0	...

Green Leafy Vegetables								
Brussels sprouts ...	0·92	0·06	1·61	11	+	+	++	...
Cabbage ...	0·39	0·03	1·27	7	+++	++	+++	...
Lettuce ...	0·31	0·06	0·54	4	++	+++	++	...
Spinach ...	0·51	0·06	0·82	6	+++	+++	+++	...
Turnip Tops ...	1·19	0·17	1·78	13	+++	+++	++	...
Other Vegetables								
Tomatoes ...	0·20	0·03	1·27	6	++	+++	+++	...
Rhubarb ...	0·17	0·02	1·03	5	...	...	+	...
Cucumber ...	0·17	0·02	0·57	3	...	+	++	...
Pumpkins ...	0·28	0·03	1·47	7	...	+	+	...
Brinjal ...	0·34	0·09	1·44	8	...	+	+	...
Cauliflour ...	0·54	0·06	1·67	9	+	+	+	...
Dhanroe (Ladies finger).	0·57	0·33	1·70	12	...	+	+	...
Nolkole ...	0·26	0·16	3·30	16	V.L.	+	+	...
Artichoke ...	0·78	0·06	5·00	24	...	+	+	...
Asparagus ...	0·68	1·00	0·66	14	+	+++	+	...
Potal ...	0·21	...	0·37	2	...	+	+	...
Fresh Fruits and Berries								
Apples ...	0·09	0·06	3·54	15	...	+	+	...
Bananas or Plantains ...	0·45	0·03	2·26	11	V L.	+	+	...
Grapes ...	0·17	0·03	3·93	17	...	+	V.L.	...
Lemons ...	0·14	0·14	0·88	5	...	+	+++	...
Oranges ...	0·25	0·03	2·69	12	+	+	+++	...

Figs ...	0·56	0·14	15·99	67	...	+	0	...
Prunes ...	0·85	0·09	11·43	50	...	+	0	...
Raisins ...	0·62	0·09	17·32	73	...	+	0	...
Tamarind ...	0·39	...	8·89	37	...	+	+	...
Miscellaneous								
Jams ...	0·06	...	19·81	79	0	0	0	...
Marmalade ...	0·06	...	19·41	78	0	0	0	...
Treacle ...	0·06	...	16·95	68	0	0	0	...
Condensed Milk ...	2·49	2·35	15·31	92	+	+	0	...
Pickles ...	0·31	0·11	1·13	7	...	...	...	...
Pepper ...	4·39	2·41	17·83	111	...	...	...	...
Infant Foods (Tinned) ...	3·59	0·93	21·56	109	...	...	0	...
Sandesh ...	5·40	6·00	12·00	124	0	0	0	...
Tea ...	...	...	...	...	0	[illegible]	0	...
Coffee ...	...	...	...	...	0	0	0	...

Three crosses (+++) mean 'rich in';
Two crosses (++) mean 'moderately rich in';
One cross (+) means 'some' or 'poor in';
0 means 'none'. V.L. means 'very little'. A blank space in the columns under 'vitamins' means that the vitamin-content has not been estimated.
Calories are given in round numbers.
One ounce equals 28·3 grammes.

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